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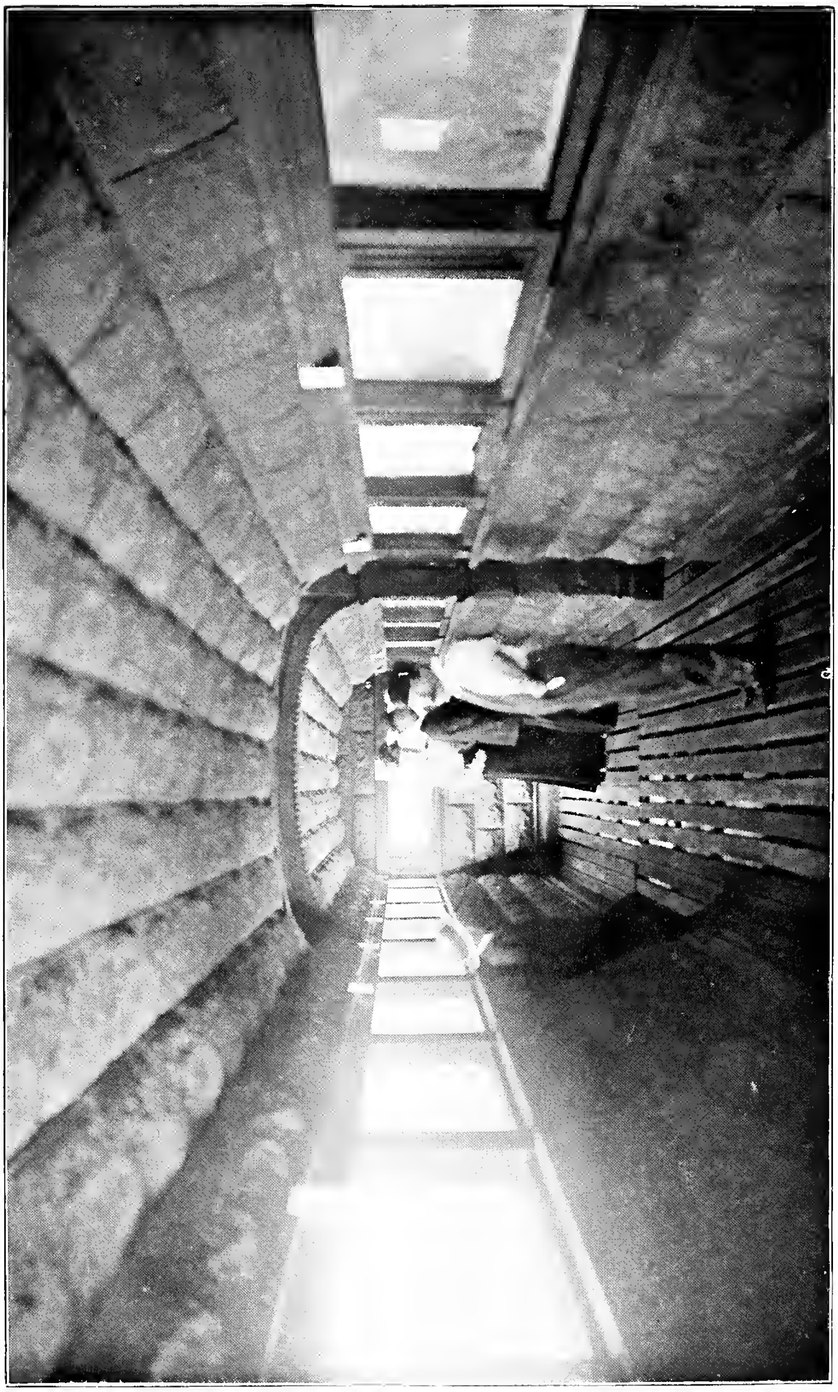

THE MARINE GROTTO IN THE UNITED STATES FISH COMMISSION BUILDING AT WASHINGTON, D. C. (Taken in July, 1897.)

EXPERIMENTS IN PHOTOGRAPHY OF LIVE FISHES.

By R. W. SHUFELDT.
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Up to the present time very few photographs of living fishes have been reproduced and published, and, as compared with the photography of other living forms, attempts or successes in this line are extremely rare. There are a number of methods by means of which fish may be photographed in their natural element, with natural surroundings, as, for example, it is possible to accomplish it beneath the surface of the water by the use of some such contrivance as the subaquatic camera used by Dr. J. E. Romborsts, or that of M. Bonton, or the apparatus of Regnard. By the employment of instantaneous photography some fishes have been taken in the air, in the act of "leaping," as in the case of salmon, or in the act of flight, as in the case of the flying-fish. Such pictures as these latter, however, illustrate peculiar habits rather than topographical characters of the forms thus secured. To obtain these we must resort to the photography of living fishes in suitable aquaria and under proper conditions. In such receptacles the types to be photographed may be taken either through the glass sides of the aquarium (with or without background) or the exposure may be made from above. This, of course, would depend upon the form of the fish and its habits in nature, or, in other words, whether the subject was a bass or a flounder. Again, certain fish in nature have the habit of occasionally resorting to the dry land, and when the opportunity offers species of this kind may be taken upon terra firma in various situations, as in the case of the peculiar gobioid *Periophthalmus.*

The experiments to be described in the present contribution, however, will be restricted to a few the author has made at the aquaria of the U. S. Fish Commission building in Washington in July, 1897, and upon various occasions since. The fish in these cases were all medium-sized teleostean types, and the photographs were first taken through the glass sides of the aquaria in which they are kept in the "Marine Grotto"; and afterwards in a special aquarium placed in the court-yard of the building during the forenoon of a perfectly clear day in July (1898)—two very different conditions. In the first instance the aquaria consist of a series of tanks arranged around a roofless corridor, thus admitting sunlight, when protective awnings are not in use, only from above. Within the grotto, this series of aquaria comes flush by glass-fronts with the wall of the long room, so named. Here they are of glass, 4 or 5 feet above the floor, and as one enters the grotto the impression is given of mural pictures wherein the fish-subjects are alive and moving about. The walls of the grotto

and its entrance are of tin, so modeled, painted, and sanded as to give the appearance of having been built in solid freestone. Practically all the light that gets into the place is through the glass fronts of the series of aquaria and the doorway passage It is an admirable arrangement and admits of the study of the forms of many kinds of fish and plants, and certain invertebrata as well. To a limited extent it likewise permits the study of some of the habits of the forms exhibited.

To one having but little knowledge of the use of the camera, it would appear to be but a simple matter to photograph under such apparently favorable conditions, but such is by no means the case. In the first place, in most instances the incessant, rapid, and often erratic movements of the fish themselves have to be taken into account; the aquaria being large, we have in the second place the difficulty of prompt focussing to contend with, due to the latitude enjoyed by the smaller and more active forms. Thirdly, there is the question of reflection, and this, taken in connection with the light, is a serious problem. Reflections are especially troublesome, as the glass fronts of the aquaria receive them from all directions, so that, after focussing, a careful study of the image upon the ground-glass will show these reflections not only from some of the other aquaria, but possibly the photographer and his camera besides. All this must be carefully guarded against.

In the early part of July, 1897, I made a number of attempts to photograph the fish contained in these aquaria through the glass-fronts, and in several instances I was successful. Where failure resulted it was due to some of the causes enumerated above, or, as in the case of a catfish, due to the high light upon the fish itself. High lights on the bodies of fish, if present at the time the exposure is made, will in the prints made from such a negative produce areas of white wherein all detail is absent. This is to be especially avoided, and often can only be overcome by shielding the aquarium from the sun above. An umbrella will in nearly all cases serve this purpose.

The camera employed upon this occasion was an old-model Blair tourograph, with a Vöigtlander lens (No. 1) (27,967), an instantaneous shutter of the Low pattern, Seed's gilt-edge plates (5 by 8). I used stops as any special case demanded. A tripod is absolutely essential to success in this kind of work. The instrument was set up in front of one of the more favorable aquaria and focussed upon the part desired and an inch or two *beyond* the surface of the glass. An armed plate-holder was inserted in place and the "snap" set. Patient waiting for an exposure when the fish swims to the place where you want it is necessary. Care must be taken in drawing or pushing back the slide to the plate-holder, and some of my failures were due to complications of this nature.

The first exposure was made upon a large pike (*Lucius lucius*), some 18 or 20 inches long and in good color and condition. It had a duration of about 2 seconds, at which time the plane of the left side of the fish's body was nearly parallel to the plane of the glass, and about 3 inches from its inner surface. A quarter of an inch diaphragm was used, and the subject remained practically motionless during the time of exposure. Overhead the light was somewhat diffused, and an additional disadvantage presented itself in the fact that the color of the pike closely simulated the shade of the metal-back of the aquarium, thus rendering strong outlines of the resulting negative a matter of doubt. However, the picture (plate 7, lower figure) was fairly good, and on comparing it with the figure of this species in "The Fisheries and Fishery Industries of the United States" (plate 183, upper figure) it is to be observed that in the living fish the pectoral fins are extended almost directly downward; and further, that the

extremities of the forks of the tail are distinctly rounded and not acute, as in the aforesaid drawing. In fact, the caudal fin, or tail, in the latter is incorrect in outline, and there are still other differences to be observed upon comparing the figure of the present paper with the figure given us by Goode, pointing to inaccuracies in the latter. Here is where the great value of the camera comes in. In time, with suitable subjects taken under the most favorable conditions, pictures of fish (as in the case of other animal forms), produced by half-toning processes from faultless photographs, will surely supersede in biological literature the often inaccurate figures that now illustrate it. This is what we strive to accomplish in our efforts to obtain the best possible photographic negatives of fish—live fish in their natural element, with normal surroundings.

On the same day I attempted to photograph the two species of sun-fish then in the aquaria. One of these was the common pumpkin-seed (*Eupomotis gibbosus*) and the other the long-eared sun-fish (*Lepomis auritus*, plate 3, upper figure). In the aquarium at the south end of the grotto there were upward of two dozen specimens of the former, while a handsome male of the latter species, with three or four females, were living in another tank at the side of the room, where the light was much more favorable. By instantaneous exposure I secured two fine negatives of the common sun-fish. One of these had twenty fish in it, all of which were swimming at the time, but the resulting picture shows not the slightest degree of motion in any one of them. There were nearly as many specimens on the second negative, here shown in plate 3, lower figure, and published for the first time in the *Photographic Times*, of New York. These results exemplify what may be expected from a highly colored fish, though rather a dark one, attempted under by no means favorable conditions, and where reliance was mainly placed upon tact, patience, and the best material that the market afforded. It will be observed that those specimens which were deep down in the water took the darkest, while those nearer the surface showed better definition. Nearly all of them, however, give the external characters of the species pretty well, and surely are far more interesting than many illustrations frequently seen in zoological works.

In the case of *Lepomis auritus* the subject selected was the single male fish, and for fully two hours, upon an intensely sultry afternoon, I was obliged to wait before this beautiful specimen came into the proper place to be photographed. The result, however, fully compensated for the delay, and the photograph is an absolutely accurate representation of the male long-eared sun-fish of our American ichthyfauna.

About a week after making these experiments very good results were also obtained with the striped sea-robin (*Prionotus evolans*) and with the naked star-gazer (*Astroscopus guttatus*). The former was taken while resting upon the bottom of the aquarium, while the latter was secured in two positions, the one where it had settled down upon a piece of flat stone, and the other an instantaneous exposure, showing the fish in the act of hiding itself in the sand, a very interesting habit that it constantly exhibits. The reproduction of my photograph of the star-gazer is shown in plate 7, upper figure, and it is a very accurate representation of this species as it appears in life.

This work was not resumed until July of the following year, when the present Commissioner, Hon. George M. Bowers, extended me additional facilities. Mr. Edw. S. Schmid had also had a special aquarium manufactured for my use, and I had the kind assistance in the experiments of Mr. Leighton G. Harron, the superintendent of the Aquaria at Central Station in Washington. I made a number of exposures upon needle-gars, black bass, and crappie. With both the former species I failed for not

having used a shutter of a sufficient degree of rapidity in closing. With the crappie, however, I obtained three serviceable negatives, two of them being very good.

On July 17, 1898, another day was given to this work, at which time the same methods and materials were used; but by the aid of former experience the results were more successful, and excellent negatives of series of three species of fish were obtained. Special good fortune attained the taking of the large-mouthed black bass (*Micropterus salmoides*), of which several negatives were made (see plate 4, upper figure). Views of the common sun-fish (*Eupomotis gibbosus*) were also obtained, far better than those secured during the year previous. These show in great detail the external appearances of this well-known fish (plate 2). The cat-fish (plate 8, upper figure) proved to be another fair result, but this form is a difficult one to photograph on a number of accounts.

Success was attained in the case of the white perch (*Morone americana*) on October 16, 1898. On this date there were two of these fish, with several sea trout (*Cynoscion maculatum*), in the northwest aquarium of the marine grotto. At the time the instantaneous exposure was made the finer of the two perch was swimming slowly over the bottom in search of food, while a broad ray of light lit up the sand just beyond him. Plate 4, lower figure, therefore, not only gives a truthful representation of this well-known species as it appears in nature, but the illustration possesses peculiar artistic merit besides, a piece of good fortune that sometimes befalls the operator. While thus occupied, this fish lowers its anterior dorsal fin and draws up its ventral ones, while the pectoral fins stand out perpendicular to the surface of the body.

A week later (October 23, 1898) a number of very successful exposures were made, and negatives were secured of the sea trout (*Cynoscion maculatum*), the tautog or black-fish (*Tautoga onitis*), and the sea bass (*Centropristes striatus*).

The sea trout, a young specimen, was in slow movement forward at the time of the exposure, and shows the anterior dorsal and ventral fins slightly drooping. The mouth is open, and the fish was doing nothing at the time beyond watching its companions in other parts of the same aquarium. The light marks on the anterior part of the body of this specimen, as well as the emargination of the tail, are due to injury and inflammation, resulting from injuries received during transportation from the seaboard to the Fish Commission building. (See plate 5, upper figure.)

The tautog (plate 5, lower figure) is a medium-sized specimen, photographed while resting in a vertical position upon the side of a little mound of sand and very close to the surface of the glass. It was in one of the west-side aquaria in the marine grotto, which also contained some ten or twelve more specimens of the same species, of various sizes. These fish in confinement exhibit all their natural traits, and in their aquarium some will be seen swimming about not far above the bottom; others will be lying upon their sides, and still others attempting to secrete themselves beneath the rocks, while occasionally exhibiting a peculiar method of combating each other. This consists in two fish (males?) coming at each other face to face, opening their mouths, and, the one bringing his teeth in contact with those of his antagonist, each attempts to force his adversary backward, or if he or the opponent be taken off guard for the instant, the more watchful fish of the two will make the attempt to bite the other. Sometimes there seems to be a certain playfulness about the grotesque maneuvers, while at others an earnest combative nature is quite apparent. Whether the opposite sexes ever engage in this procedure I am unable to say at this writing. At the best the tautog is a peculiar fish in its habits, and their behavior together often

reminds me of that of a litter of little pigs, with some of the movements characterized by a certain kind of cat-like fawning. They feed voraciously and take with avidity their natural food, but in the aquarium they usually receive crushed crabs.

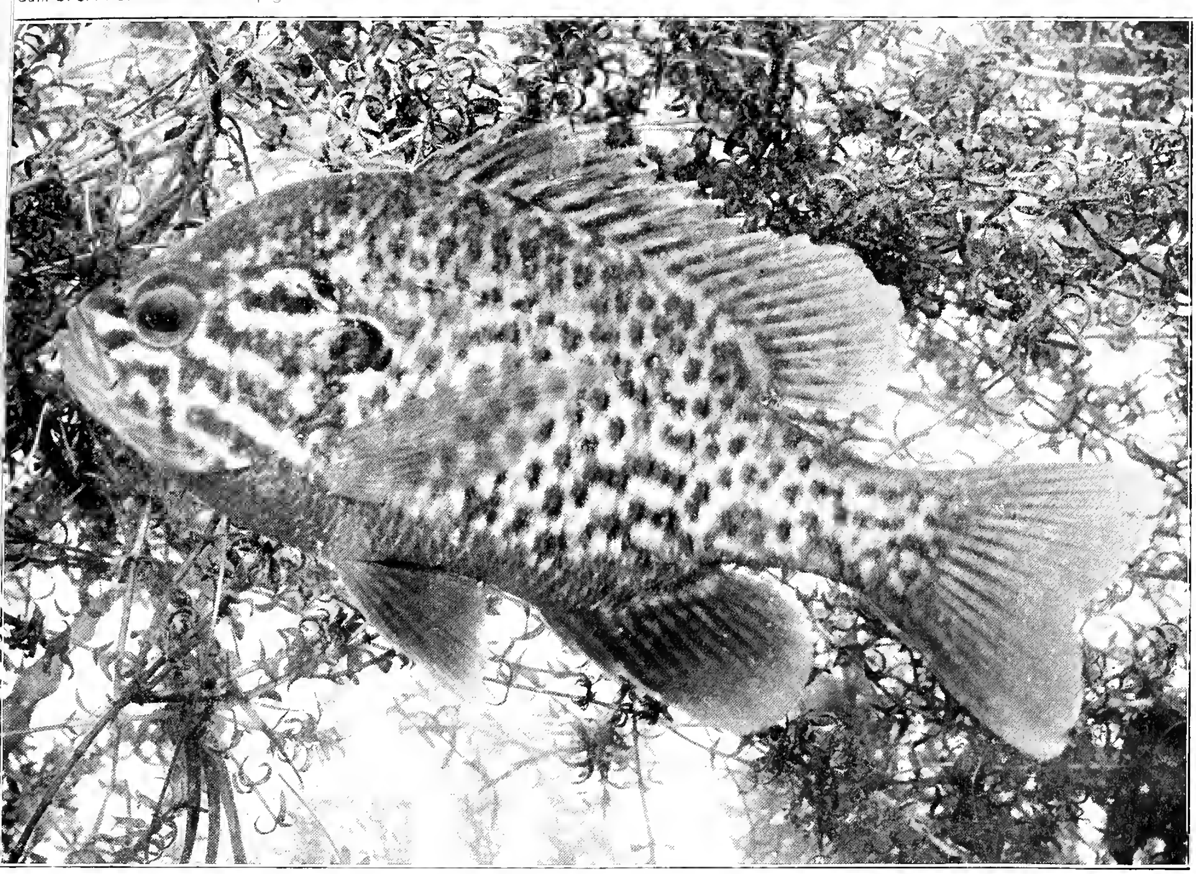
The specimen represented in plate 5, lower figure, shows the handsome vertical markings and mottlings that the tautog frequently assumes. At other times it is ot a dull leaden-black all over, while some specimens show every variety of intergradation between these two extremes. These changes, it would appear, are almost wrought at the fish's will, or they may be indicative of the humor it is in, or a color may be assumed that renders the fish less likely to be observed, and this is doubtless of value to it in its native waters, where all fish have enemies of one kind or another.

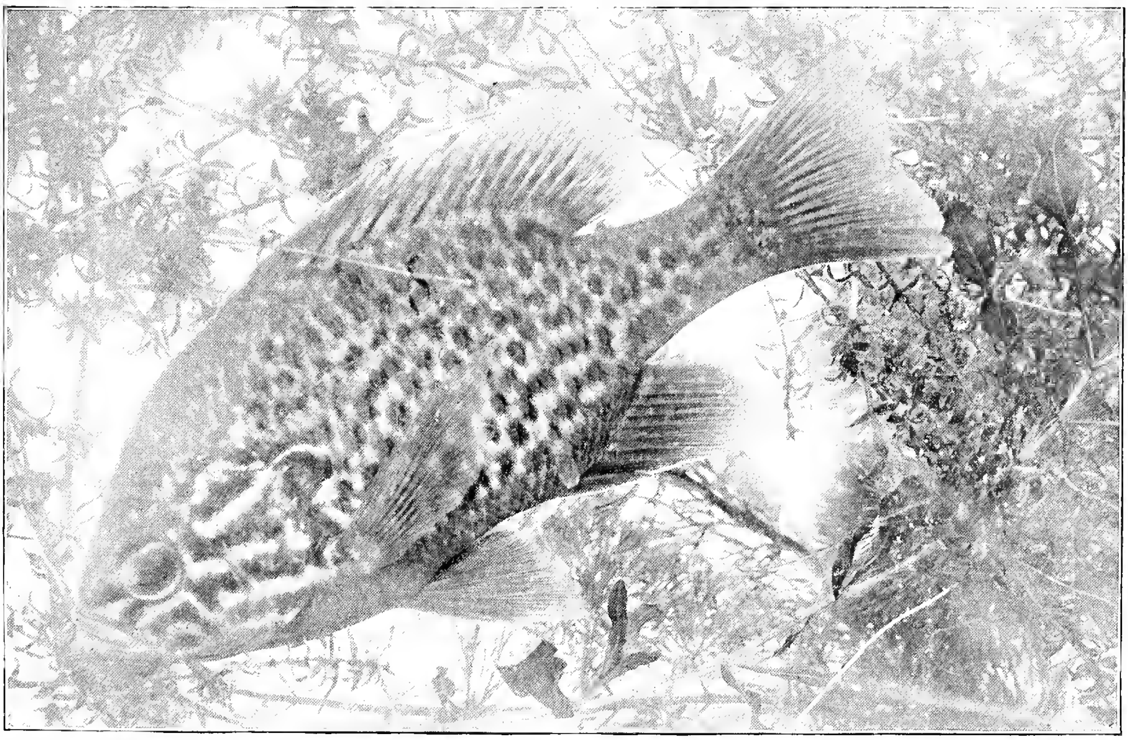
On the same day this tautog was photographed I secured two successful negatives of the young of the sea bass (*Centropristes striatus*). There were a number of these fish of various sizes in one of the aquaria on the west side of the grotto, and the light at the time of taking was excellent. Instantaneous exposures were given, and in one instance the specimen was taken just as it came to rest upon the bottom (plate 6, lower figure), while in the other it had assumed that remarkable attitude of resting upon its pectoral and anal fins that it has in nature (plate 6, upper figure). Both of these results present us with all of the external characters of these fish, and are valuable on that account. This species undoubtedly has the power of changing its color at will, both for the purposes of protection as well as to indicate the play of the humor it may happen to be in. The various shades are assumed very suddenly, quite as much so as I have seen them to be in the American chameleon (*Anolis principalis*) of the Southern States.

Sea bass have beautiful eyes, that change color a little at times, though usually they are of a brilliant emerald green, which unfortunately photographs very dull and pale. Their large and handsome fins are almost constantly in motion, rendering it extremely difficult to catch this species with the camera. The distal extremity of the upper lobe of the tail is seen to project slightly as a blunt point, but is never in the young extended as an elongated ornamental filament. In the adult, however, of a southern species (*Centropristes ocyurus*) both the upper and lower lobes of the caudal fin are thus filamentously produced.

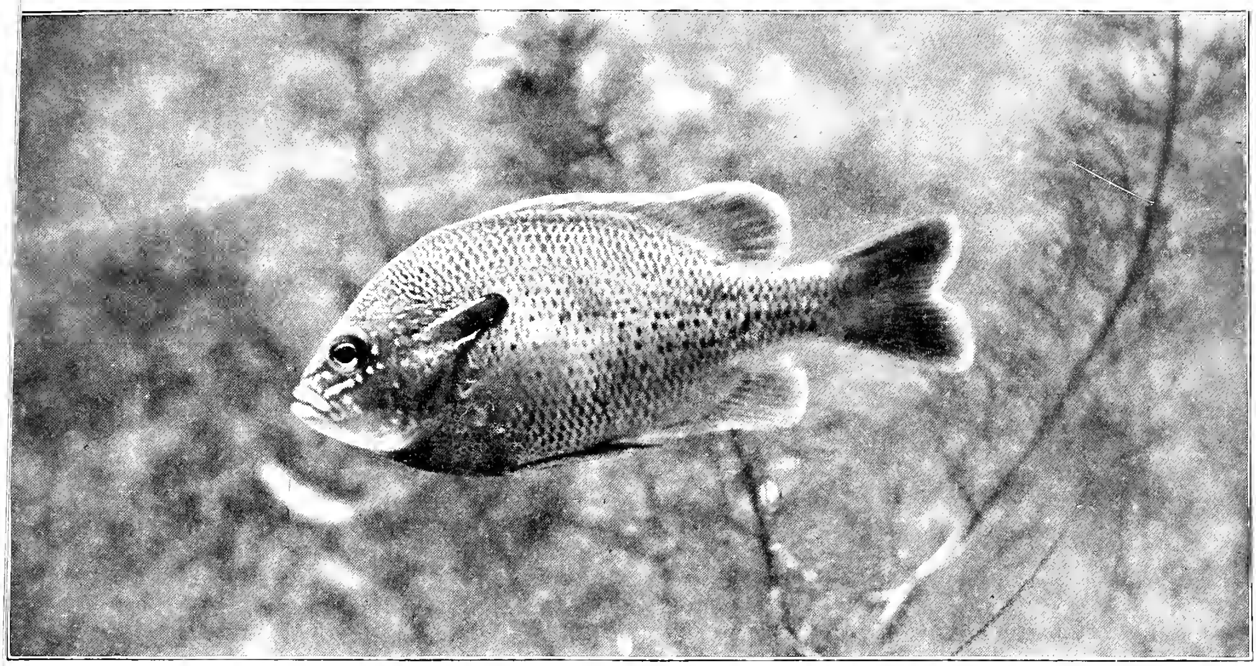
I have also examined specimens of sea bass wherein the middle three rays of the tail were likewise somewhat drawn out in this manner. These examples were in the Washington Center Market (October 26, 1898), and were said to have come from New York. The upper and lower caudal lobes were light-colored, and it was only in the former that any indication of a filament was noticed, and that only in some few of the specimens. These fish were probably *Centropristes ocyurus*, wherein the tails had suffered mutilations due to transportation after capture.

Some of the difficulties which attend the photography of living fish are seen in plate 9, from an instantaneous exposure (made October 23, 1898) upon the north end aquarium of the grotto, when there were swimming in it 450 rainbow trout (*Salmo irideus*). Necessarily some of the number were out of focus. The lower ones show but little detail, owing to being in the shadow caused by the great mass of fish above them, others are indistinct from lateral shadows, and at the best the light at the time of exposure was not of the kind to insure the most perfect success; nevertheless, this result is a very interesting one, and probably not many photographs extant, if any, show so many examples of swimming fish upon the one plate, where not a single individual of them exhibited the least movement in its photograph.

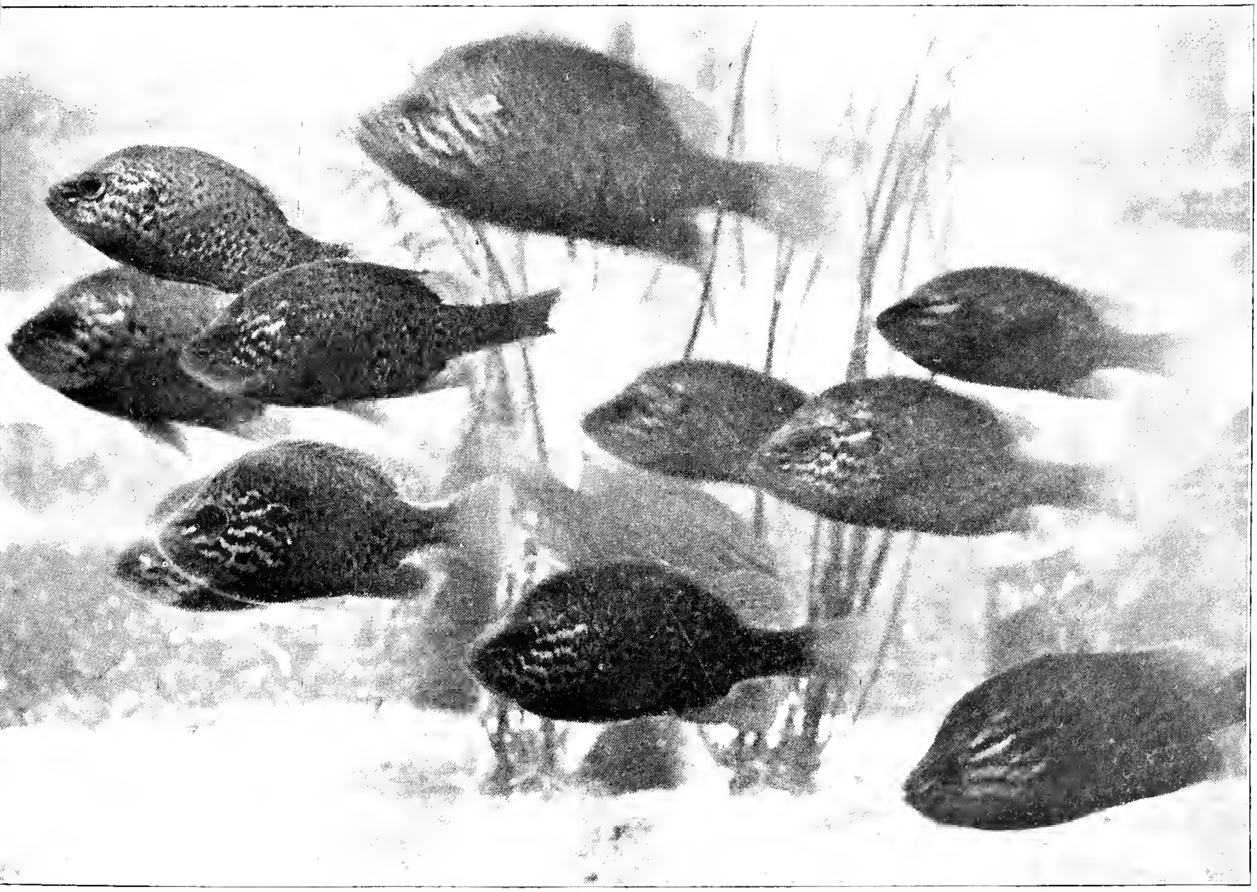




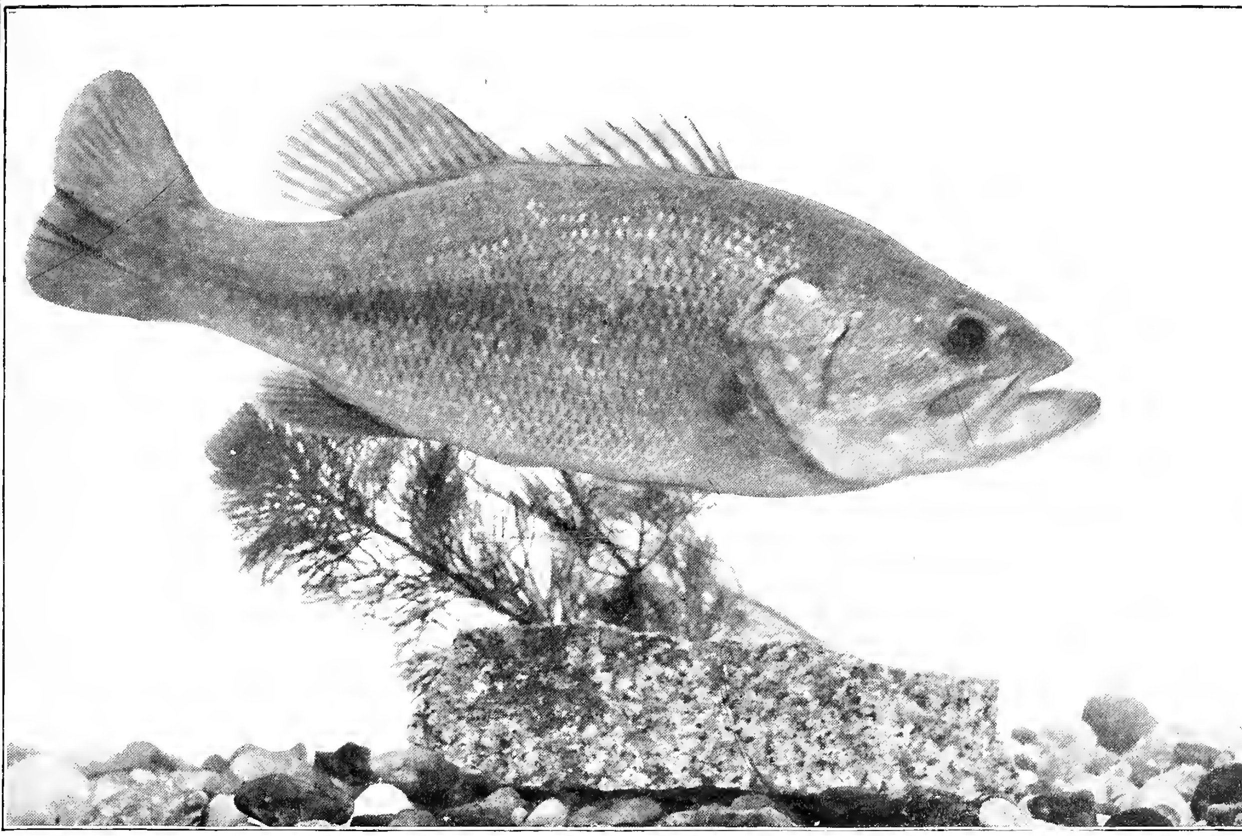
COMMON SUN-FISH (*Eupomotis gibbosus*). Upper figure, natural size; lower figure, slightly reduced.



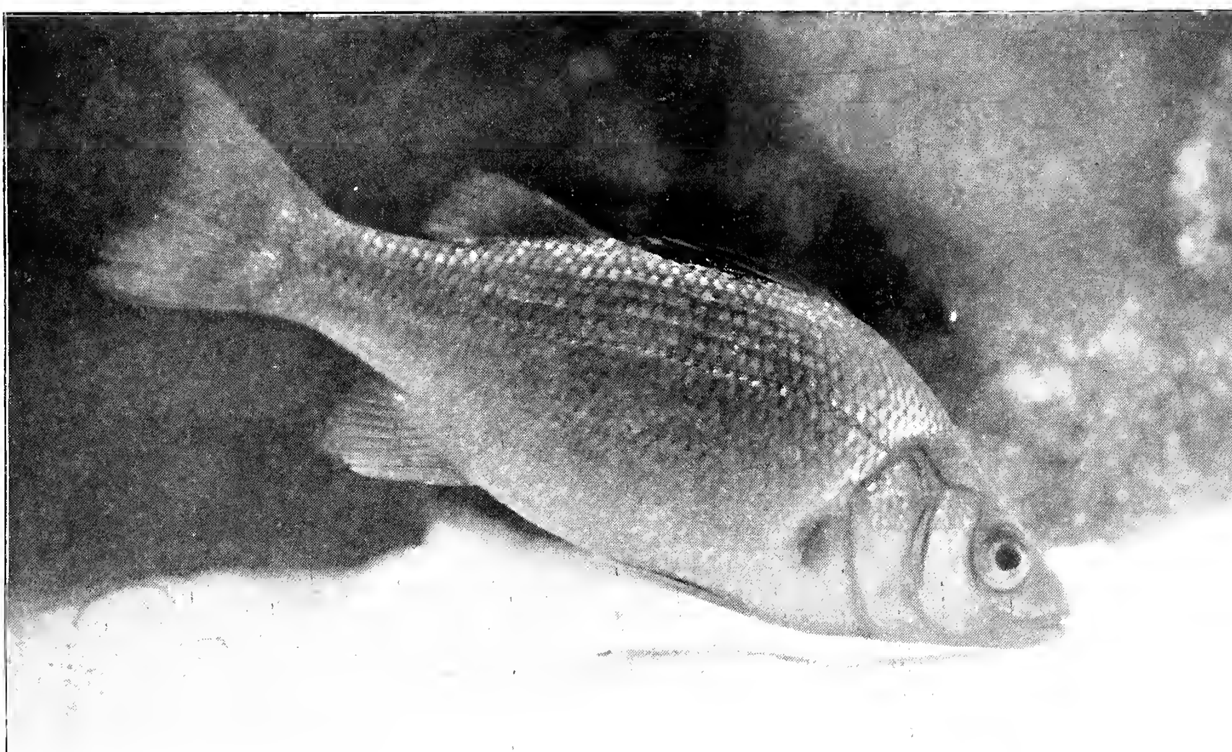
LONG EARED SUN-FISH (*Lepomis auritus*). Reduced about one-third.



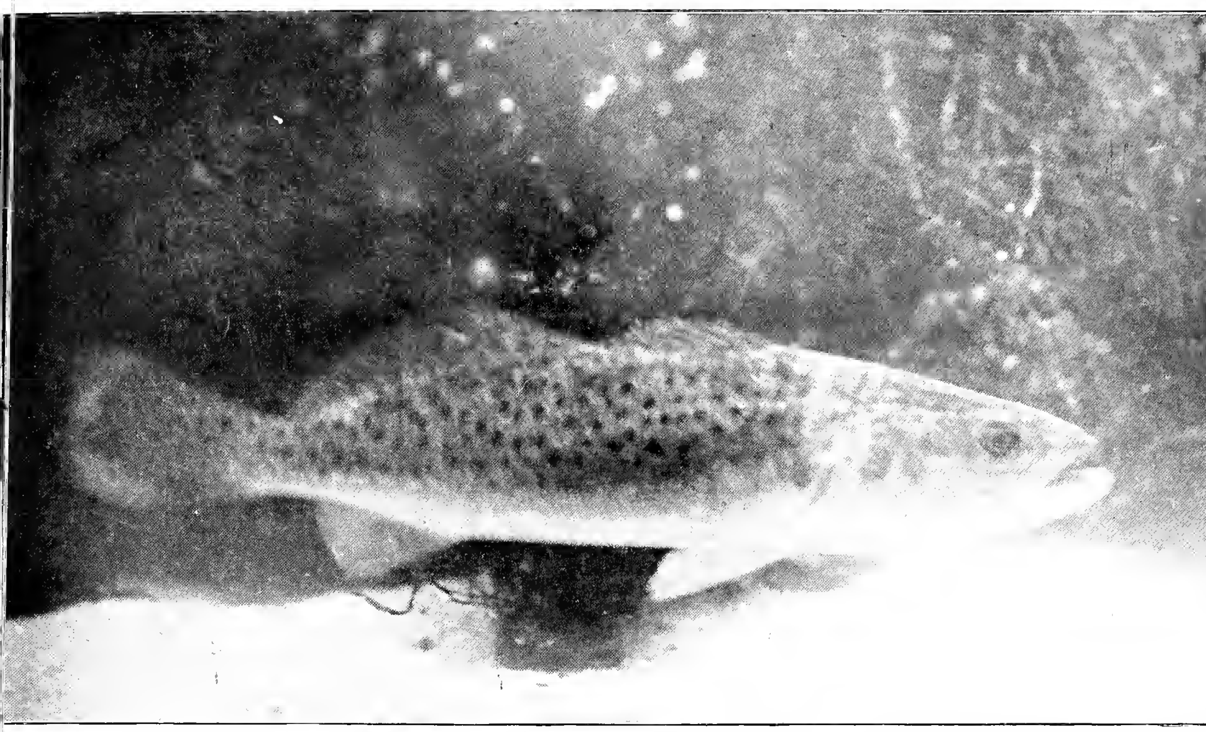
GROUP OF COMMON SUN-FISH (*Eupomotis gibbosus*).



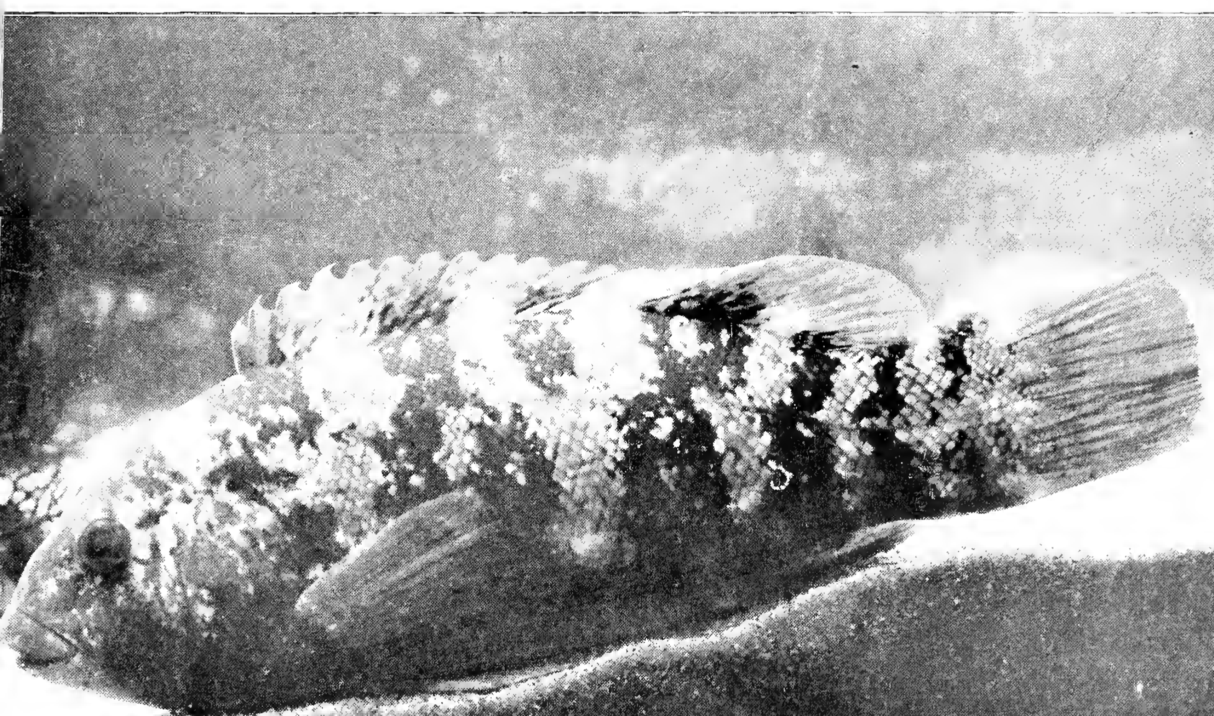
THE LARGE-MOUTHED BLACK BASS (*Micropterus salmoides*). Slightly reduced.



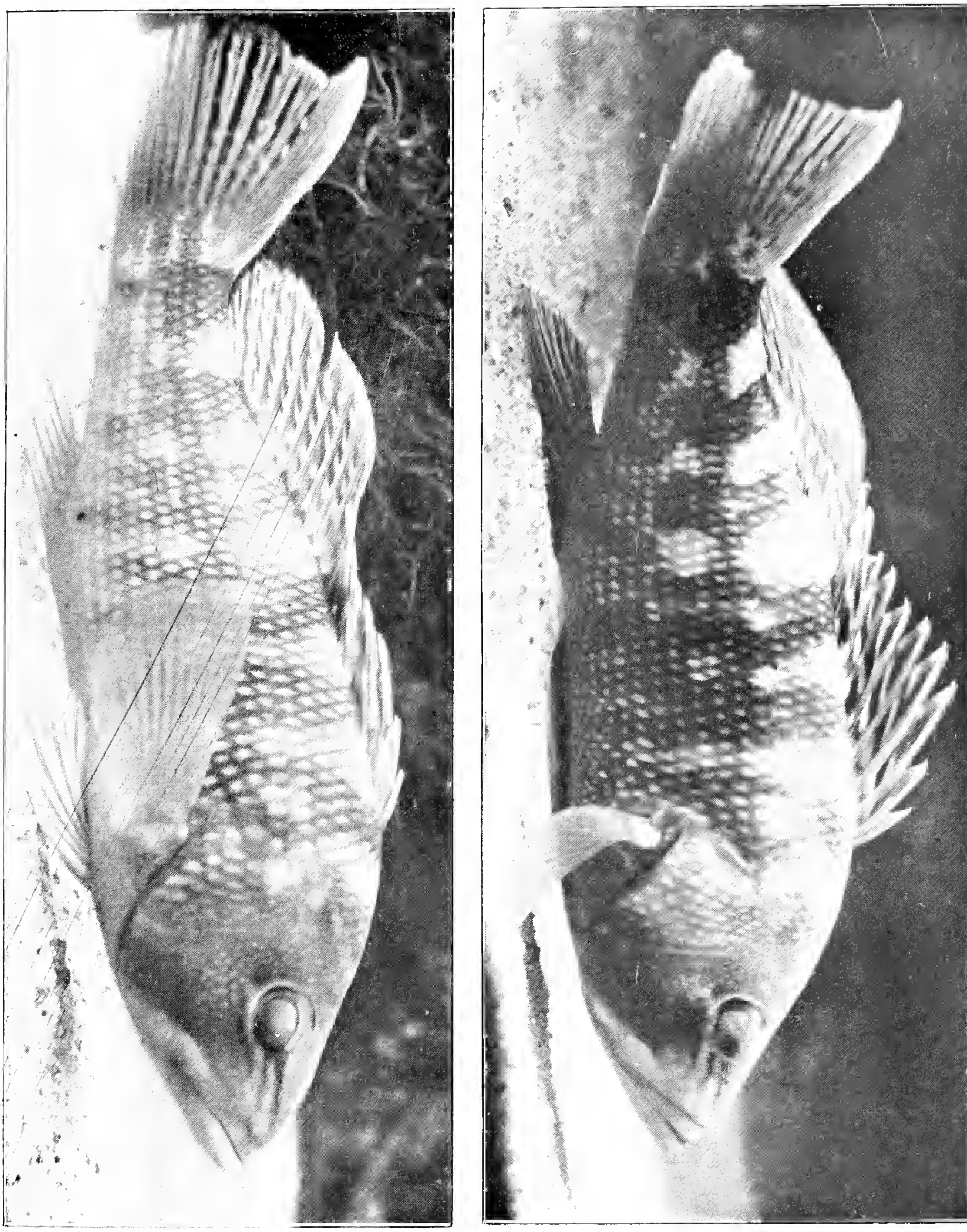
THE WHITE PERCH (*Morone americana*). Two-thirds natural size. Represents the fish searching for food along the bottom of the aquarium, similar to the habit it has in nature.



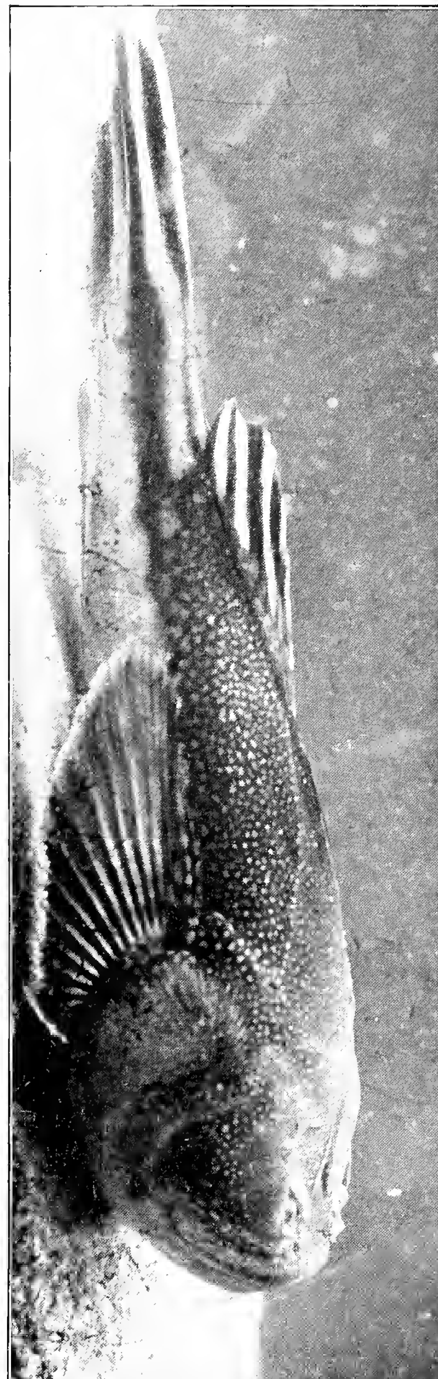
THE SPOTTED SEA TROUT OR SQUETEAGUE (*Cynoscion maculatum*). One-half natural size.



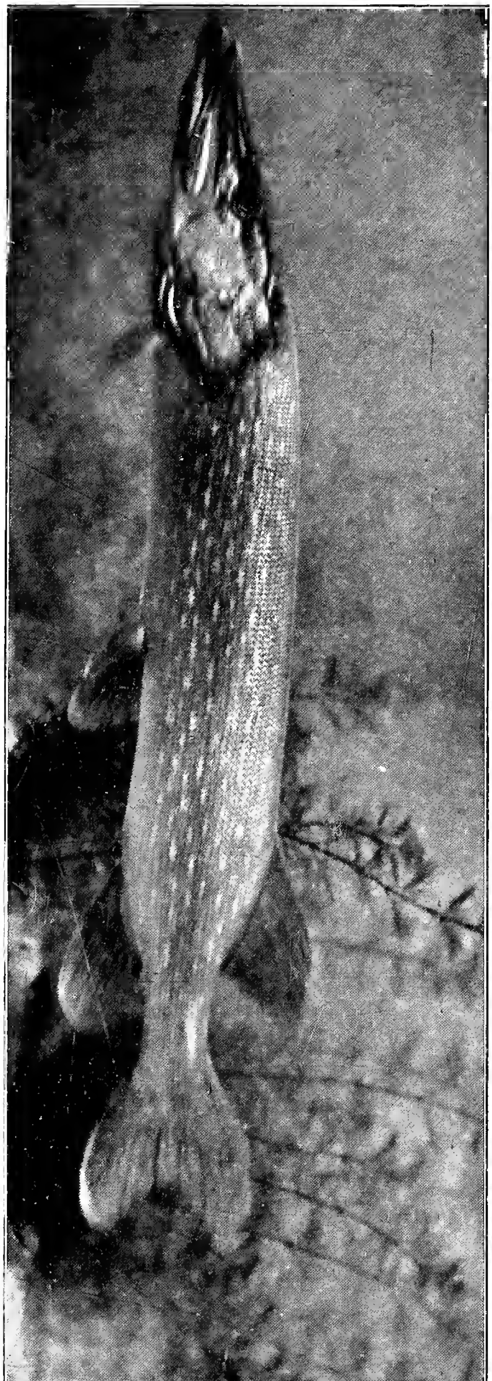
THE TAUTOG OR BLACK FISH (*Tautoga onitis*). Nearly natural size. Exhibiting the fish resting on the bottom, a habit it has commonly in nature.



THE SEA BASS (*Centropristes striatus*). Different specimens.

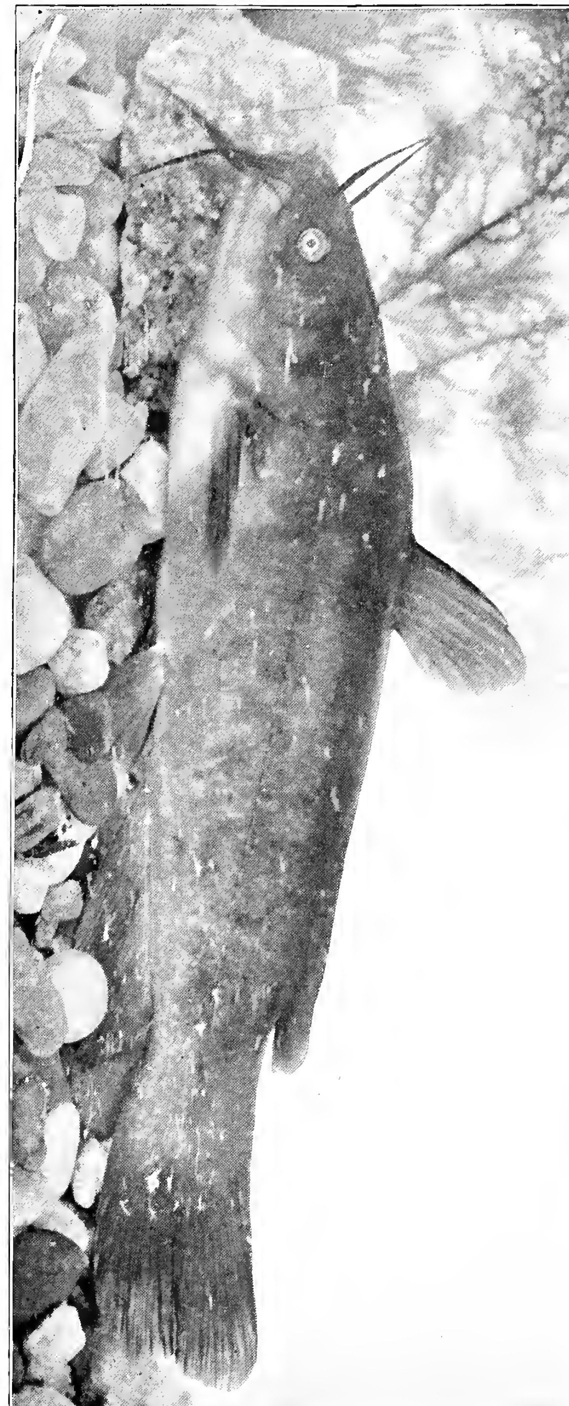


THE NAKED STAR-GAZER (*Astroscopus guttatus*). Slightly reduced.

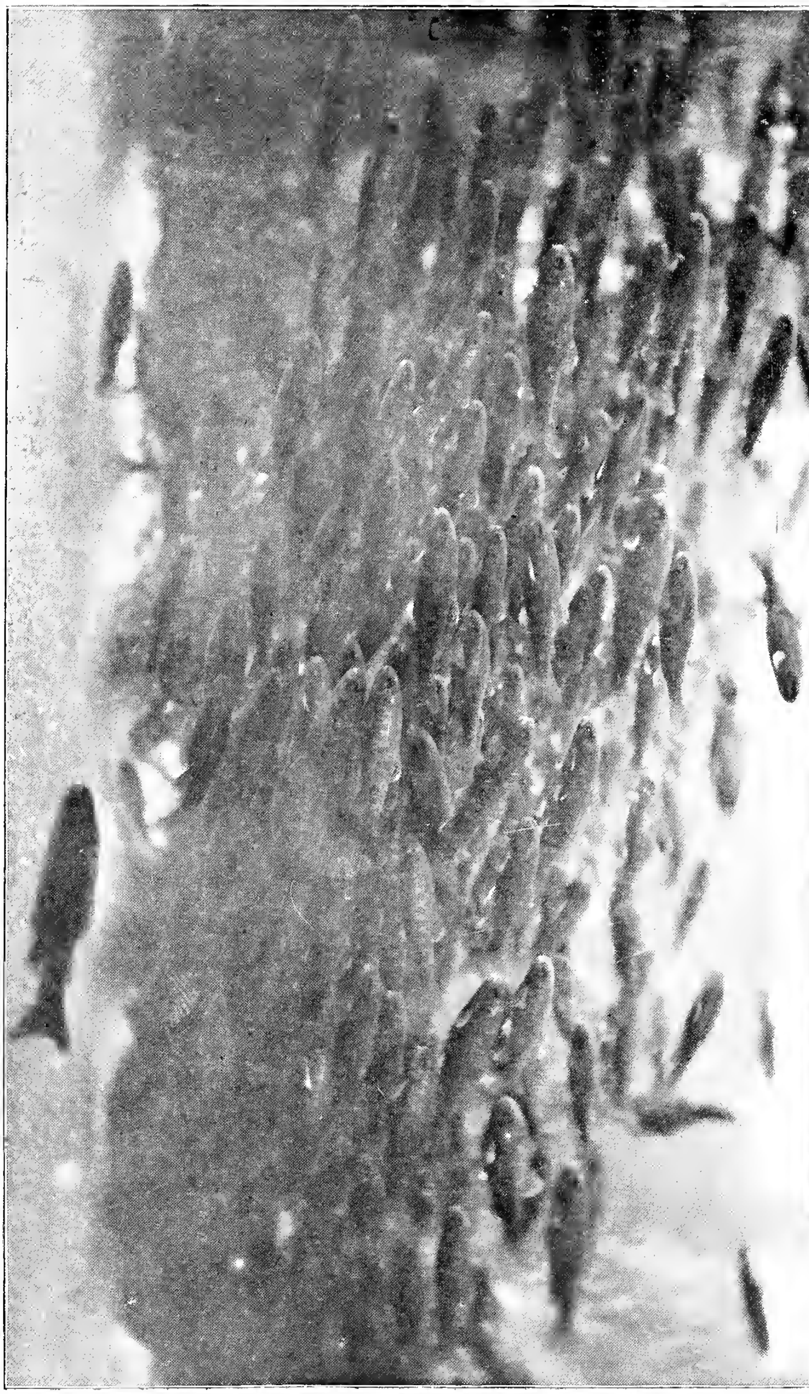


THE PIKE (*Lucius lucius*). Left lateral view.

THE BROOK TROUT (*Salvelinus fontinalis*). Natural size. Taken July, 1897.



THE CAT-FISH (*Ameiurus nebulosus*). Somewhat reduced.



YOUNG RAINBOW TROUT (*Salmo irideus*). Four hundred and fifty specimens in the aquarium when instantaneous exposure was made.

NOTES ON THE TIDE-POOL FISHES OF CALIFORNIA, WITH A DESCRIPTION OF FOUR NEW SPECIES.

BY ARTHUR WHITE GREELEY,
Teacher of Biology, San Diego State Normal School.

This paper is based on collections made on several trips along the coast of California from San Francisco Bay to Point Sur, in Monterey County, in 1897 and 1898. The fishes were taken exclusively in the tide-pools exposed at low water and were captured with small hand nets. Calcium hypochlorite or ordinary chloride of lime (bleaching powder) was used with excellent effect for stupefying the fishes in small, isolated tide-pools. The fishes were taken out as soon as they came to the surface and were killed in dilute alcohol or formalin.

The following new species were obtained: *Eximia rubellio*, *Rusciculus rimensis*, *Dialarchus snyderi*, and *Blennicottus recalvus*, three of them representing new genera, *Rusciculus*, *Eximia*, and *Dialarchus*. One of these species, *Dialarchus snyderi*, is mentioned in the addenda of Jordan & Evermann's Fishes of North and Middle America as *Oligocottus snyderi*, but it is now made the type of a new genus and is fully described and figured for the first time. The group of tide-pool cottoids, the allies of *Oligocottus*, are here subjected to a critical revision, in view of the confused state of the literature concerning them.

The group of *Cottidæ* of the type *Oligocottus*, comprising the genera *Oligocottus*, *Blennicottus*, *Clinocottus*, and *Oxycottus*, and the new genera *Eximia*, *Rusciculus*, and *Dialarchus*, is distinguished from the rest of the family by the separation of the gill membranes from the isthmus, the presence of palatine teeth, and either the entire nakedness of the body or the presence of only rudimentary, prickly scales. They are all strictly tide-pool fishes of the Pacific coast, ranging from Bering Sea to Lower California and never wandering far from shore. Each species inhabits, with surprising regularity, only certain kinds of tide-pools, its distribution depending almost entirely upon the character of the rocks and the kind of algæ present. They all imitate very closely the color of their surroundings, and two or three species show parallel color phases, each copying after a certain kind of alga. Thus, depending on these conditions of rock and plant life, there are along almost any part of the coast two or three zones of vertical distribution, one species inhabiting the deeper tide-pools, another the shallower, and so on, as will be seen by reference to the descriptions. *Clinocottus analis* offers a marked exception to these generalizations, however, as it is found in every kind of tide-pool within its range.

The first known species of this group were described by Girard as follows: *Oligocottus maculosus* in 1856, *O. analis* in 1857, and *O. globiceps* in 1858. These last two species were made types of new genera by Gill in 1861, giving them the names *Clinocottus* and *Blennicottus*. These two genera of Gill were not recognized by Jordan &

Gilbert in their Synopsis of 1883, the genus *Oligocottus* being made to include all three species; but they were finally restored in Jordan & Evermann's Check-List of 1896. To the genus *Oligocottus* there have been since added the species *acuticeps* (Gilbert, 1893), *embryum* (Jordan & Starks, 1895), and *borealis* (Jordan & Snyder, 1896); to *Blennicottus* the variety *B. globiceps bryosus* (Jordan & Starks, 1896). The status of these species has remained unchanged, except that Jordan & Evermann, in The Fishes of North and Middle America, have considered *Oligocottus acuticeps* the type of a new genus, *Oxycottus*, to which they have transferred also *Oligocottus embryum*. This nomenclature is here adopted, except in the genera *Oligocottus* and *Blennicottus*, where confusion in specific identification has taken place and a reassignment of specific names is necessary. Girard's original species, *Oligocottus maculosus* and *Blennicottus globiceps*, were described respectively from Tomales Bay, north of San Francisco, and from the Farallon Islands, off San Francisco. Both are now shown to be forms of northerly distribution, the type locality being, in each case, near the southernmost limit of the range. Southward along the coast each is replaced by a distinct species, both of which are abundant at Monterey Bay. Recent authors have, unfortunately, identified Girard's names with specimens from Monterey Bay, while the northern species to which his names should apply have been rechristened *Oligocottus borealis* and *Blennicottus globiceps bryosus*. Therefore these two names are now abolished, the species becoming *Oligocottus maculosus* and *Blennicottus globiceps*, and the southern forms are described as new species, *Dialarchus snyderi* and *Blennicottus recalvus*, the former being also made the type of a new genus.

The different species of this group resemble each other to a remarkable degree in external appearance, yet most of them are separated by characters which we now consider of generic importance. The characters are all remarkably constant except that of color, which varies greatly with the surroundings and can not be described with great exactness. The color descriptions given in this paper are all from life, and have been made broad enough to cover all the specimens examined. The character and arrangement of the cirri afford perhaps the best specific distinguishing features, and not the slightest variation from the adult plan has ever been discovered in these species. The features of generic importance in this group are the character of the preopercular spines, the presence or absence of scales, the shape and size of the head and mouth, and the nature of the first three or four anal rays of the male. There may be one, two, or several rays enlarged, or they may be all of normal size, the number of modified rays and the amount of enlargement always remaining the same in any one species; furthermore, these enlarged rays may or may not be separated from the rest of the fin. I have used the form and size of the preopercular spines for the primary divisions of the key, and this arrangement brings together the species nearest alike in geographical range and external appearance. The presence or absence of scales can not be considered a mark of less importance, however, and the two together stand out distinctly as dividing the species into natural groups. All of these species have a slit behind the last gill except *Blennicottus embryum* and *Rusciculus rimensis*. This seems to be an important character in determining the relationships of the species.

The tables accompanying the descriptions give the various dimensions of the body in hundredths of the total length to base of caudal.

The author is under deep obligations to Dr. Charles H. Gilbert, in whose laboratory and under whose direction the work was carried on, and to President David Starr Jordan, whose suggestions and advice have been of great help.

Key to Genera and Species allied to Oligocottus.

I. Preopercular spine simple, not forked or branched.
a. Scales none; no enlarged anal rays in the male; anal papilla present in the male.
b. Blennicottus. Head very wide and blunt; mouth terminal, mainly transverse.
c. Cirri of head few, none on interorbital space, two regular rows above the eyes, and a few on sides of head; preopercular spine scarcely appreciable .... B. RECALVUS.
cc. Cirri of head numerous, entirely covering the occiput and interorbital space, a thick bunch above preopercular spine and opercular flap; preopercular spine nearly half diameter of eye, curved upward .... B. GLOBICEPS.
bb. Oxycottus. Head pointed; mouth extending laterally below eye.
d. Cirri of head mossy or joined at base; four occipital bunches; dorsal fins separate. O. EMBRYUM.
dd. Cirri of head single or double; three occipital bunches; dorsal fins slightly joined at base; anal papilla of male very large, situated between ventrals ......O. ACUTICEPS.
aa. Rusciculus. Dorsal half of body closely scaled; first two anal rays of male enlarged; no anal papilla; cirri of head small, single, or rarely doubled; one supraorbital, three occipital, one nasal, one maxillary, and two or three preopercular cirri; lower margin of preopercle bluntly toothed .... R. RIMENSIS.
II. Preopercular spine forked at tip.
e. Scales none; one or more anal rays enlarged in the male; anal papilla inconspicuous.
f. Dialarchus. First anal ray of male enlarged, joined to second, the two widely separated from rest of fin; cirri of head joined at base, two supraorbital bunches, three on occipital, a thick preopercular bunch, an opercular one, and a few on sides of head; a row of cirri along the dorsal fin close to its base .... D. SNYDERI.
ff. Oligocottus. Three or four anterior anal rays of male enlarged, not separated from rest of fin and becoming progressively smaller posteriorly; cirri of head irregular, usually one supraorbital and three or four occipital bunches in which all the cirri are joined at base; no cirri along dorsal fin, except in the young or one or two scattering ones in the old; maxillary reaching a vertical below center of pupil.................... O. MACULOSUS.
ee. Clinocottus. Scales present, sometimes obscure in adults; no enlarged anal rays; anal papilla present, large; cirri scattered irregularly over top of head in four irregular occipital rows, and in old individuals extending back on body along nearly entire length of dorsal fin, and down over anterior and dorsal half of body, none below lateral line, no scales on anterior half of body in the old; a fringe of cirri on preopercle, a thick bunch on opercle, and five or six cirri on maxillary.................. C. ANALIS.
III. *Eximia.* Preopercular spine three-pointed. Scales none; eye and nasal spines large; first anal rays of male enlarged, second slightly elongated, not separated from fin; anal papilla inconspicuous; cirri not joined at base, three supraorbital and three occipital pairs of bunches of two or three each; a maxillary bunch, a preopercular row, and an opercular bunch of cirri, and a few scattered ones on side of head; a row along dorsal fin bending downward at end of spinous dorsal; scattered cirri between the dorsal row and lateral line, and below lateral line behind pectoral fins .... E. RUBELLIO.

LIST OF FISHES.

Blennicottus recalvus Greeley, new species. Fig. 1.

Centridermichthys globiceps Günther, Cat., II, 171, 1860.

Oligocottus globiceps Jordan & Gilbert, Synopsis, 718, 1883.

Blennicottus globiceps Jordan & Starks, Proc. Cal. Ac. Sci. 1895, 808; Jordan & Evermann, Fishes of North and Middle America, II, 2017, 1898; not *Oligocottus globiceps* Girard.

Head 3.66; eye 4.75 in head; snout 3; D. IX, 15 or 16; A. II, 12; P. 14.

Body short, stout, broad anteriorly; head very broad, short and blunt; snout obtuse; interorbital space five-sixths of eye, grooved, the groove leading into a depressed space behind eyes; mouth distinctly terminal, maxillary reaching a vertical below anterior edge of orbit, lower jaw included; minute conical teeth on jaws, vomer, and palatines; nasal spines very small; no preopercular spine apparent in adults; edge of preopercle rounded; opercle ending in a rounded flap; branchiostegals 6, membranes broadly united, free from isthmus; gills 3½, a slit behind last gill.

Dorsal fins very long, slightly joined at base, origin of first dorsal directly over tip of opercle, that of soft dorsal in advance of origin of anal; first dorsal slightly rounded, middle ray longest; pectorals reaching origin of anal, membranes of first seven rays deeply emarginated; ventrals reaching vent; anal papilla of male very large; anal low, membranes of all the rays except last three deeply emarginated, none of rays enlarged in male; caudal short, slightly rounded.

Cirri few and small, those of top of head joined at base in conspicuous bunches, two irregular occipital rows, a few below these on sides of head and on margins of preopercle and opercle; a few above origin of pectoral, and a weak row along anterior third of lateral line.

Color of body light brown, vermiculated with white, and marked dorsally with four or five wedge-shaped spots of dark brown, edged with white, and more distinct posteriorly; two pinkish spots on dorsal side of caudal peduncle, and a faint shading of same color on sides of head and along anterior fourth of lateral line; entire undersurface dull brown, tinged with olive; fins indistinctly barred with grayish-white; tail faintly tinged with pink. In some specimens the color is an almost uniform dull brown, while in others light markings are prominent. Some young individuals from among green algæ are uniform light green.

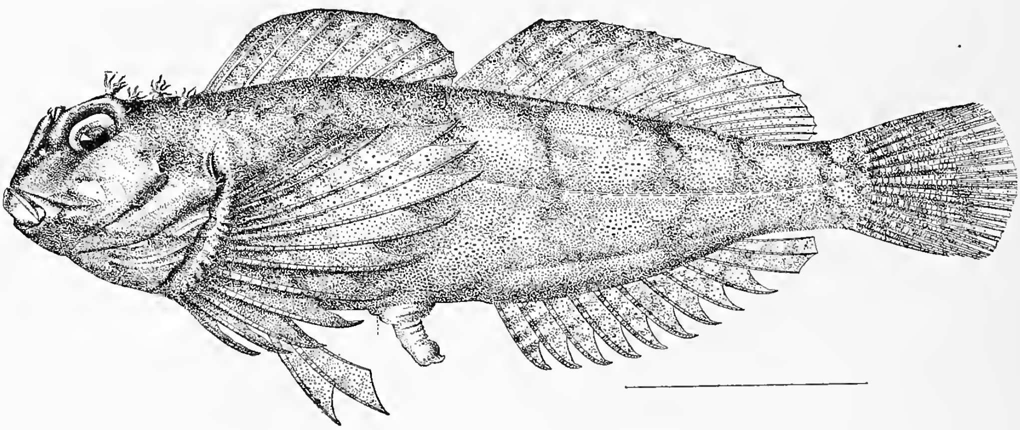


FIG. 1.—*Blennicottus recalvus* Greeley. Type.

Comparative measurements of five specimens of Blennicottus recalvus.

Measurements.	Collectors and localities.				
	Pacific Grove, L. S. Jr. U. M. (4245).	Greeley & Cowles, Pacific Grove.	Greeley & Spaulding, Santa Cruz.	Greeley & Spaulding, Santa Cruz.	Greeley & Spaulding, Santa Cruz.
Extreme length in millimeters	85	92	80	75	72
Greatest height of body	26	25	28	27	26
Least height of caudal peduncle	9	9	10	10	10
Length of caudal peduncle	17	16	16	18	17
Length of head	29	29	28	28	29
Width of head	25	26	24	24	24
Width of interorbital space	4	5	5	5	5
Height of head at pupil	17	18	17	18	18
Length of snout	9	9	9	8	9
Diameter of orbit	6	6	5	5	6
Distance from snout to spinous dorsal	24	26	25	24	25
Length of spinous dorsal at base	27	27	33	25	28
Height of spinous dorsal	10	9	9	9	11
Length of soft dorsal at base	41	40	39	42	41
Height of soft dorsal	12	12	15	12	13
Distance from snout to anal	60	56	55	56	57
Height of longest anal ray	14	12	14	14	15
Length of caudal	19	17	20	19	24
Distance from snout to pectoral	30	30	28	28	30
Length of pectoral	33	29	31	29	34
Distance from snout to ventral	34	32	29	31	31
Length of ventral	21	19	21	21	22
Number of dorsal spines	9	9	9	9	9
Number of dorsal rays	16	16	15	16	16
Number of anal rays	12	12	12	11	11
Number of pectoral rays	14	14	14	14	14

The bluntness of snout and preopercular spines, and the terminal mouth make *B. recalvus* easily distinguishable from all related forms except *B. globiceps,* from which it is separated by the shape and size of its preopercular and nasal spines, the number of its cirri, 12, and size of its mouth. The adults of these two species can be readily distinguished, but the young of *B. recalvus* is very similar to young of *B. globiceps,* indicating that *B. globiceps* is probably the ancestral form. Girard's old description of *Oligocottus globiceps* has been erroneously associated with this fish, which does not extend so far north as the type locality of *O. globiceps. B. recalvus* is distributed from San Diego to Santa Cruz, where it is immediately succeeded by *B. globiceps* on the north. No specimens of *B. recalvus* have been taken north of the region of Santa Cruz. On the other hand several specimens of *B. globiceps* have been collected on the coast of Monterey County south of Monterey Bay, therefore within the range of *B. recalvus.* The relations between the two species where their ranges overlap is still to be made out. *B. recalvus* is quite common throughout its range and everywhere inhabits deep-shaded tide-pools, near low-water mark, where a large number will often be found in a single pool. Here described from a specimen collected at Pacific Grove by Greeley & Cowles. (Type, No. 6068, L. S. Jr. Univ. Museum.)

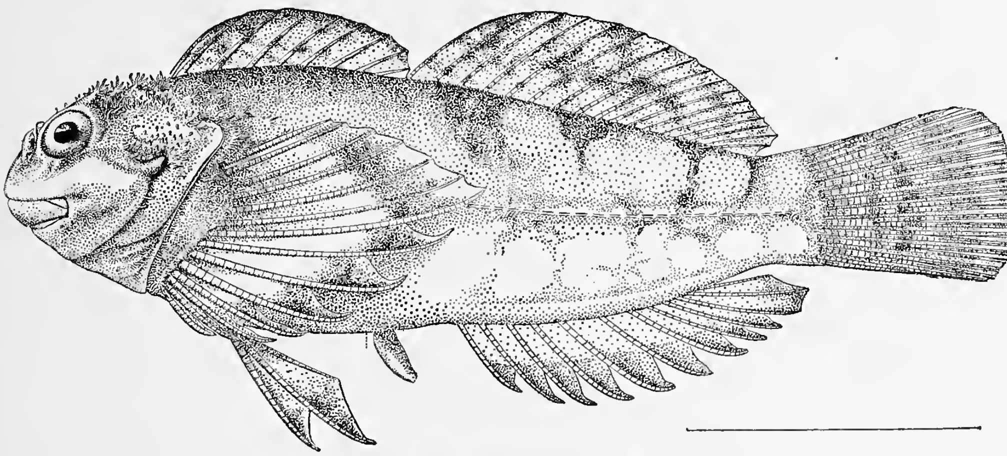


FIG. 2.—*Blennicottus globiceps* (Girard).

Blennicottus globiceps (Girard). Fig. 2.

Oligocottus globiceps Girard, U. S. Pac. R. R. Surv., Fish., 58, 1858, South Farallones.

Blennicottus globiceps bryosus Jordan & Starks, Proc. Cal. Ac. Sci. 1895, 808, Point Orchard, near Seattle; Jordan & Evermann, Fishes of North and Middle America, II, 2017, 1898.

Girard's original description of this fish has been erroneously associated with the very closely related species *B. recalvus,* which replaces it south of Santa Cruz. *B. globiceps bryosus* was based upon this northern form, the typical *globiceps,* and to it the original name is now restored.

Head 3.66; eye 4.75; snout 3; D. IX, 16 or 17; A. 11 or 12; P. 13 or 14.

Body short, stout; head deep, blunt, with a short decurved snout; interorbital space five-sixths of eye, deeply grooved; mouth nearly terminal and transverse, with slight lateral cleft, the maxillary reaching a vertical through the center of orbit; lower jaw included. Preopercular spine single, curved upward, nearly half diameter of orbit; nasal spines prominent, nearly half diameter of eye; opercle ending in a rounded flap. Dorsal fins long, slightly joined at base; no anal rays enlarged in male; anal papilla large.

Cirri very numerous on top and sides of head, extending through the interorbital groove to nasal spines, two rows of prominent joined cirri on top of head, others between these, still others on sides of head; a large bunch above preopercular spine and on dorsal margin of opercle, a V-shaped row above pectorals, and a thick row along anterior half of lateral line.

Color, light plumbeous brown, with traces of four or five more or less distinct black transverse bands, the whole body more or less vermiculated with white; some specimens largely streaked with white vermiculations, others nearly uniform brown; under parts dull white tinged with brown on under lip, and with yellow posteriorly; fins barred with yellow. The northern form of this species

lighter in color; young individuals frequently uniform plumbeous black with a conspicuous transverse band of silvery white on anterior part of body. Four to 5 inches long, specimens from Puget Sound 7 inches.

Very close to *B. recalvus*, which is its southern representative. Known from Puget Sound to Pigeon Point, San Mateo Co., Cal., where it stops abruptly, *B. recalvus* succeeding it immediately to the south. A few specimens have been taken, however, immediately south of Monterey Bay, within the range of *B. recalvus*. Its occurrence to the south needs further investigation.

Comparative measurements of six specimens of Blennicottus globiceps.

Measurements.	Collectors and localities.					
	E. C. Starks, Neah Bay, Washington, L. S. Jr. U. M. (3404).	E. C. Starks, Neah Bay, Washington, L. S. Jr. U.M.(3404).	Greeley & Cowles, Pillar Point.	Greeley & Cowles, Pillar Point.	Greeley & Spaulding, Pigeon Point.	Greeley & Spaulding, Pigeon Point.
Extreme length in millimeters	144	77	63	61	73	71
Greatest height of body	31	28	28	30	28	28
Least height of caudal peduncle	9	10	10	10	10	10
Length of caudal peduncle	15	16	16	16	16	17
Length of head	26	28	28	29	29	27
Width of head	23	23	24	24	25	24
Width of interorbital space	5	5	5	5	5	5
Height of head at pupil	17	18	17	18	17	17
Length of snout	9	9	8	9	9	9
Diameter of orbit	5	6	6	6	6	6
Distance from snout to spinous dorsal	22	25	25	25	24	24
Length of spinous dorsal at base	32	31	27	29	28	27
Height of spinous dorsal	10	9	9	10	10	9
Length of soft dorsal at base	41	43	42	41	42	44
Height of soft dorsal	13	11	14	14	12	13
Distance from snout to anal	57	55	55	55	56	55
Height of longest anal ray	14	14	16	16	15	14
Length of caudal	19	22	25	24	19	21
Distance from snout to pectoral	26	28	30	30	29	29
Length of pectoral	32	31	33	31	32	31
Distance from snout to ventral	28	31	34	31	31	30
Length of ventral	21	22	24	23	22	21
Number of dorsal spines	9	9	9	9	9	9
Number of dorsal rays	16	17	16	16	17	16
Number of anal rays	11	11	11	11	12	11
Number of pectoral rays	14	14	14	13	14	14

Oxycottus acuticeps (Gilbert).

Oligocottus acuticeps Gilbert, Rept. U. S. Fish Comm. 1893 (1896), 432, Unalaska; Vancouver Island. (Coll. *Albatross*.)

Oxycottus acuticeps Jordan & Evermann, Fishes of North and Middle America, II, 2015, 1898. Vancouver Island to Unalaska, Alaska; Bean & Bean, Proc. U. S. Nat. Mus., vol. 21, 1898, 665.

This fish has been reported also from Prince William Sound (coll. A. W. Greeley), from Kadiak Island (coll. C. Rutter), and from Sitka and Kadiak by Dr. Bean.

Oxycottus embryum (Jordan & Starks).

Oligocottus embryum Jordan & Starks, Proc. Cal. Ac. Sci. 1895, 808, pl. 82, Neah Bay, Washington (type, No. 3128, L. S. Jr. University Museum. Coll. E. C. Starks).

Oxycottus embryum Jordan & Evermann, Fishes of North and Middle America, II, 2016, 1898.

Several additional specimens of this interesting and apparently rare species were obtained at Point Lobos. Color, dull lavender, marked dorsally with five or six indented spots of black; irregular vermiculations of same color on sides of body, which is bounded below by a band of reddish-brown, containing many conspicuous white spots; a reddish-brown spot on top of head indented and edged posteriorly with white; two reddish-brown bands running downward from eye; pectoral pinkish, barred with olive; dorsals, anal, and caudal barred with brown; throat and under side of thorax silvery-white; belly pale-greenish. Distinguished from the species of *Blennicottus* by the sharpness of the snout and preopercular spines, and the lateral extension of mouth.

This is one of the rarest and most beautiful of the tide-pool cottoids. The prevailing lavender tint in its coloration imitates closely the *Corallina*, among which it lives in the deeper tide-pools. It is recorded only from Point Lobos, Monterey County, Cal., from Puget Sound, and from Sitka and Karluk, Alaska.

Comparative measurements of five specimens of Oxycottus embryum.

Measurements.	Starks, Neah Bay, Washington (type), L. S. Jr. U. M. (3128).	Starks, Neah Bay, Washington, L. S. Jr. U. M. (3128).	Snyder, Point Lobos, L. S. Jr. U. M. (3428).	Greeley & Cowles, Point Lobos, March, 1898.	Greeley, Point Lobos, June, 1898.
Extreme length in millimeters	55	51	49	36	41
Greatest height of body	24	23	23	22	23
Least height of caudal peduncle	8	8	8	8	8
Length of caudal peduncle	18	19	19	18	18
Length of head	28	27	29	28	29
Width of head	21	21	21	20	21
Width of interorbital space	6	6	5	6	6
Height of pupil	14	14	14	14	14
Length of snout	8	8	8	9	8
Diameter of orbit	6	7	6	7	7
Distance from snout to spinous dorsal	24	25	25	26	25
Length of spinous dorsal at base	31	30	28	25	27
Greatest height of spinous dorsal	10	10	11	12	10
Length of soft dorsal at base	37	37	35	36	37
Height of longest ray of soft dorsal	14	14	14	14	15
Distance from snout to anal	52	51	52	58	50
Height of longest anal ray	14	15	14	14	15
Length of caudal	20	20	19	19	20
Distance from snout to pectoral	29	28	30	31	29
Length of pectoral	35	36	37	36	31
Distance from snout to ventral	30	30	34	37	30
Length of ventral	22	23	23	23	22
Number of dorsal spines	9	9	9	9	9
Number of dorsal rays	16	16	15	15	15
Number of anal rays	11	11	10	10	10
Number of pectoral rays	14	14	14	14	14

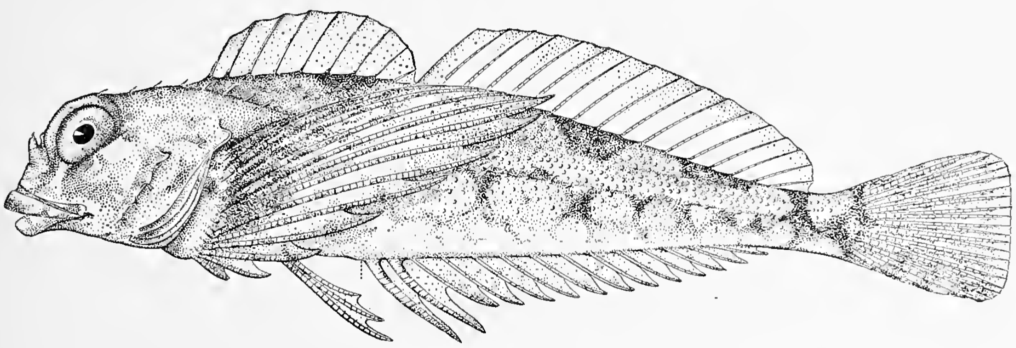


FIG. 3.—*Rusciculus rimensis* Greeley, type.

RUSCICULUS Greeley, new genus.

This genus is allied to *Oxycottus*, differing in the presence of minute prickly scales, which cover dorsal half of body. Preopercular spine simple, sharp. No slit behind the last gill.

Rusciculus rimensis Greeley, new species. Fig. 3.

Head $3\frac{1}{2}$; eye 4 in head; snout $3\frac{1}{2}$ in head; D. IX, 17 or 18; A. 14; P. 14; V. I, 3.

Body compressed, very slender, caudal peduncle especially so; head depressed, flat; snout pointed; interorbital space $\frac{5}{6}$ eye, grooved; top of head flat and slightly concave; nasal spines large and blunt, snout abruptly decurved below them. Dorsal half of body covered with minute, imbedded, prickly scales partially arranged in obscure oblique rows, none below lateral line. Minute pointed teeth on jaws, vomer, and palatines; jaws subequal, mouth horizontal, maxillary reaching a vertical below anterior edge of pupil. Margin of preopercle armed with one sharp spine curved upward, below which are one and sometimes two very short blunt processes; margin of opercle ending dorsally in a pointed flap. Branchiostegals 6, the membranes broadly united, free from isthmus; no slit behind last gill. Dorsal fins scarcely joined, soft dorsal very large; first dorsal beginning slightly in advance of opercular flap, upper edge much rounded, fifth spine longest; origin of soft dorsal just in front of origin of anal in female, directly above it in male, fin very long; pectorals large, reaching a vertical below ninth ray of soft dorsal; origin of ventrals posterior to a point midway between anal

and base of pectorals in male, anterior to it in female, the difference caused by enlargement of first two anal rays in male; anal fin small, rays slender, membranes of all deeply emarginated; first two anal rays of male greatly enlarged, joined by membrane to each other and to rest of fin; posterior edge of tail nearly straight; anal papilla inconspicuous. Cirri small and scarce, always occurring singly, never in bunches or joined at the base, except a few pairs along anterior third of lateral line, one above each orbit, two rows of three each behind these on top of head, one cirrus on inside of each nasal spine; a cirrus on end of maxillary, two or three on margin of preopercle below preopercular spine, and a row along anterior half of lateral line.

Color, light olive or reddish brown tinged with lavender, marked dorsally with four or five wedge-shaped indented spots of black, a broken band of same color along lateral line, sometimes sending branches below it, which show a tendency to inclose round spots; a more or less distinct spot of black on top of head; a faint postocular line, a spot below eye, and a preocular line running from eye to snout, all of same color; pectorals and caudal indistinctly barred with brown, anal tinged with it, and dorsal covered with fine brown or black spots, sometimes very faint; throat and belly pale yellowish-white, unspotted.

This species is most closely related to *Oxycottus embryum*, with which it agrees in general coloration, but differs decidedly in the presence of scales, the slenderer body, the larger number of soft dorsal and anal rays, the serrated margin of the preopercle, and the arrangement of the cirri.

Described from two specimens taken at Point Lobos, Monterey County, Cal., by A. W. Greeley. (Type, No. 6067, L. S. Jr. Univ. Museum.) Rare; only two other specimens from Point Lobos are known. It inhabits tide-pools lined with corallines, and in coloration imitates very closely these algæ. Length, 40 mm. The smallest of our tide-pool fishes.

Comparative measurements of two specimens of Rusciculus rimensis.

Measurements.	Collectors and localities.	
	Greeley, Point Lobos (type), June, 1898.	Greeley, Point Lobos, June, 1898.
Extreme length, in millimeters	40	39
Greatest height of body	20	22
Least height of caudal peduncle	6	7
Length of caudal peduncle	17	16
Length of head	29	28
Width of head	23	23
Width of interorbital space	7	7
Height at pupil	15	16
Length of snout	9	9
Diameter of orbit	7	7
Distance from snout to spinous dorsal	28	28
Length of spinous dorsal at base	24	27
Greatest height of spinous dorsal	10	9
Length of soft dorsal at base	48	47
Height of longest ray of soft dorsal	15	15
Distance from snout to anal	43	48
Height of longest anal ray	15	14
Length of caudal	19	19
Distance from snout to pectoral	30	27
Length of pectoral	39	38
Distance from snout to ventral	32	32
Length of ventral	18	18
Number of dorsal spines	9	9
Number of dorsal rays	17	18
Number of anal rays	14	14
Number of pectoral rays	14	14
Length of first anal ray (male)	21	....

DIALARCHUS Greeley, new genus.

Preopercular spine forked at tip; scales none; first anal ray of male enlarged, joined to second, the two widely separated from rest of fin. Closely allied to *Oligocottus*, differing only in character of anal rays of male.

Dialarchus snyderi Greeley, new species. Fig. 4.

Centridermichthys maculosus Günther, Cat. Fishes, II, 171, 1860; not *Oligocottus maculosus* Girard.

Oligocottus maculosus Jordan & Gilbert, Synopsis, 718, 1883; Jordan & Evermann, Fishes of North and Middle America, II, 2013, 1898.

Oligocottus snyderi Greeley, in Jordan & Evermann, Fishes North and Mid. Amer., III, 2871, 1898.

Head $3\frac{1}{4}$; eye $4\frac{1}{4}$ in head; snout $3\frac{1}{2}$; D. VIII, 18 or 19; A. 13 to 15; P. 13 to 15; V. I, 3.

Body elongate, slender; snout pointed, compressed; minute conical teeth on jaws, vomer, and front of palatines; jaws equal; mouth horizontal, maxillary 3 in head, reaching a vertical below anterior edge of pupil. Interorbital space five-sixths of eye, shallowly grooved, the groove leading into a depressed space between occipital ridges; nasal spines large. Margin of preopercle armed with a strong spine, half as long as eye, from upper border of which at base extends a second spine pointing abruptly upward and inward; both spines covered with skin in life; margin of opercle ending in a pointed flap, entirely unarmed. Branchiostegals 6, the membranes broadly united, free from isthmus. Gills $3\frac{1}{2}$, a slit behind last gill.

Dorsal fins large, separated by half diameter of eye, whole length equaling that from caudal to base of pectoral; first dorsal beginning slightly in advance of margin of opercle, upper edge nearly straight, curving abruptly downward from sixth spine; origin of soft dorsal in advance of anal; pectorals large, reaching well beyond origin of anal; ventrals almost midway between base of pectorals and anal; anal fin small, rays all feeble in female, in male the first ray only greatly enlarged, joined to second, the two distinctly separated from rest of fin, membranes of all except last three or four rays deeply emarginated. Anal papilla small, present in male only. Cirri very numerous, usually occurring in bunches of three or four, those of head joined at base, forming a comb; two pairs of bunches above orbits, with rudiments of a third bunch in front of these, three on top of head, behind orbits, two or three bunches just below these on sides of head, two or three single cirri on margin of preopercle, a thick bunch above preopercular spines, four or five on lower margin of opercle, with a thick bunch on its upper margin: a short row above base of pectorals; a row of bunched cirri along

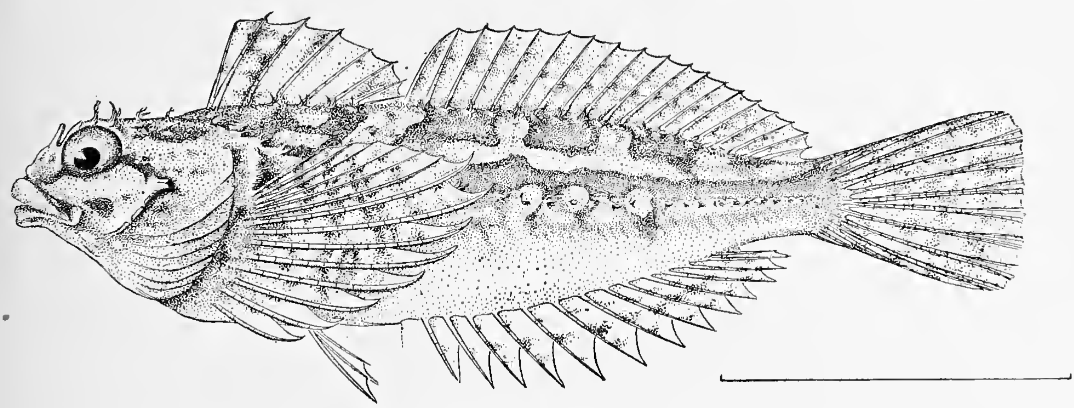


FIG. 4.—*Dialarchus snyderi* Greeley. Type.

anterior two-thirds of lateral line, another well-defined row along dorsal fin from third spine to sixteenth or seventeenth ray of soft dorsal, this row containing a bunch at base of each spine and ray, with the occasional exception of the first ray; five or six scattered bunches between dorsal and lateral rows on each side of the body; a cirrus at tip of each dorsal spine.

Color, light reddish-brown, sometimes almost pink, thickly spotted with fine indistinct white spots; four or five irregular dark-brown spots along base of dorsal, a band of same color along lateral line, sometimes very much broken and extending ventrally, shading into uniform reddish-brown below, and including three or four round pinkish spots; a dark-brown postocular line, another running forward from eye, a patch of same color on top of head, another on sides of head, and two or three on edge of opercle; throat reddish-brown, with several distinct white spots; belly bluish-green; a silvery white patch between bases of pectorals; dorsal fins pale reddish-brown, with black and clear spots; pectorals crossed irregularly with white; anal fin pale pink, crossed with dark brown. There are two or three perfectly distinct types of coloration, as follows: Some specimens from pools containing green algæ are pure light green; others from coralline pools are tinged with lavender, as *B. embryum*.

This species resembles most closely *O. maculosus*, which name has been erroneously applied to it, but it differs markedly in its slenderer body, more pointed snout, the arrangement of its cirri, and the perfectly distinct coloration, also in greater length of dorsal fins, the enlargement of only one anal ray in male, and shortness of maxillary.

Here described from a specimen taken at Pacific Grove, by Greeley & Maddren. (Type, No. 5846, L. S. Jr. Univ. Museum.) Five cotypes were taken at the same time. Specimens are at hand from Crescent City, Bolinas Bay, Half Moon Bay, Monterey Bay, and San Luis Obispo, Cal. Found in all kinds of pools from San Francisco to Monterey Bay, but nowhere common. Length, 60 mm. The most beautiful and active of the tide-pool fishes, extremely variable in color.

Comparative measurements of eleven specimens of Dialarchus snyderi.

Measurements.	Collectors and localities.										
	McGregor, Monterey, L. S. Jr. U. M. (4048).	Albatross, Monterey, L. S. Jr. U. M. (3642).	Snyder, Pillar Point.	Greeley & Maddren, Pac. Grove (cotype).	Greeley & Cowles, Pacific Grove.	Greeley & Cowles, Pacific Grove.	Greeley & Maddren, Pac. Grove (type).	Greeley & Cowles, Pillar Point.	Greeley & Spaulding, Santa Cruz.	Greeley & Spaulding, Santa Cruz.	Greeley & Spaulding, Santa Cruz.
Extreme length in millimeters	58	64	59	56	61	54	60	36	65	65	62
Greatest height of body	26	24	24	23	25	23	24	26	28	24	25
Least height of caudal peduncle	8	8	8	7	8	8	7	8	8	8	8
Length of caudal peduncle	17	17	17	17	17	15	15	18	16	18	17
Length of head	33	31	31	32	31	31	32	34	31	31	30
Width of head	26	24	23	24	23	24	25	26	22	22	25
Width of interorbital space	5	5	5	6	5	6	5	6	6	5	5
Height of head at pupil	14	14	14	15	15	15	15	16	15	15	15
Length of snout	9	9	9	9	8	9	9	9	9	8	9
Diameter of orbit	6	6	5	6	6	6	6	6	6	6	6
Distance from snout to spinous dorsal	30	29	27	27	26	29	29	30	28	27	28
Length of spinous dorsal at base	23	25	23	21	25	22	23	21	26	24	25
Greatest height of spinous dorsal	10	10	10	10	11	10	9	9	9	9	10
Length of soft dorsal at base	44	45	44	43	44	43	43	43	44	43	42
Height of longest ray of spinous dorsal	12	13	13	14	13	16	13	17	12	12	14
Distance from snout to anal	43	50	44	50	48	45	50	50	45	43	47
Height of longest anal ray	14	13	13	13	13	13	12	13	13	13	13
Length of caudal	22	21	21	21	22	21	20	22	18	20	20
Distance from snout to pectoral	32	32	30	31	29	32	32	33	29	29	29
Length of pectoral	34	33	31	31	31	34	32	34	32	36	35
Distance from snout to ventral	32	31	32	32	29	33	33	32	27	29	29
Length of ventral	17	17	17	17	18	17	17	17	17	17	17
Number of dorsal spines	8	8	8	8	8	8	8	8	8	8	8
Number of dorsal rays	19	19	19	18	18	19	19	18	19	18	19
Number of anal rays	14	14	15	14	13	14	14	14	15	13	14
Number of pectoral rays	14	14	14	14	13	14	14	14	14	14	15
Length of first anal ray, male	24	...	22	...	...	23	...	...	...	23	...

Oligocottus maculosus (Girard).

Oligocottus maculosus Girard, Proc. Ac. Nat. Sci. Phila. 1856, 153; Girard, U. S. Pac. R. R. Sur., x, Fishes, 56, 1858.

Oligocottus borealis Jordan & Snyder, Proc. Cal. Ac. Sci., series 2, vol. vi, 1896, 225, Neah Bay (coll. E. C. Starks, type, No. 3396, L. S. Jr. Univ. Museum); Jordan & Evermann, Fishes of North and Middle America, ii, 2014, 1898.

This species was described by Girard in 1856, from specimens taken at Tomales Bay, but this account was erroneously associated with another fish, now recorded as *Dialarchus snyderi*. It was rediscovered and described as a new species, *O. borealis*, by Jordan & Snyder, from a large series of specimens taken at Puget Sound; but Girard's original name is now restored, as there is no doubt that this is Girard's species. In this opinion Professors Jordan and Gilbert and Mr. Snyder fully concur. A series taken by Dr. Jordan at Sitka and a specimen collected by me at Prince William Sound extend the range northward to the latter point. It is the most common tide-pool fish at Crescent City, Del Norte County, Cal., and also at Half Moon Bay, where the shallow open tide-pools with little algæ suit the species very well. South of Half Moon Bay it gradually becomes scarcer, but extends as far as Pigeon Point. None was taken at Santa Cruz or Pacific Grove. The absence of this species south of Pigeon Point is probably due to a change in the character of the tide-pools. Below Pigeon Point the coast is made up of great shelving ledges of very hard sandstone, with few pools. North of Pigeon Point the rocks are much softer and contain shallow pools. Wherever found, this species inhabits all kinds of tide-pools, but especially those with dull surroundings, either bare rocks or rocks covered with Fucus, the brown seaweed.

Young individuals occasionally have a few cirri along the dorsal fin, on the opercle, and above the pectoral fins, probably showing a reversion to a type resembling *Dialarchus snyderi*.

Color, light brown, a very soft gray in some specimens, varying from almost olive to a dull brown in others; marked dorsally with fine white spots, which become larger below and shade into the pale olive of belly; some specimens tinged with milk-white or lavender, with a series of spots of same color along lateral line; fine dark-brown transverse bands, varying greatly in distinctness, extend downward from dorsal fin, first two reaching the belly, last three interrupted; a white spot at base of tail, usually one on dorsal side of caudal peduncle; head uniform with body, but more or less vermiculated with white or olive; throat olive, spotted with white, the ground color becoming pale on belly and along the sides of the anal; fins light olive, barred with brown.

Comparative measurements of nine specimens of Oligocottus maculosus.

Measurements.	Collectors and localities.								
	Jordan, Sitka, L. S. Jr. U. M. (5658).	Jordan, Sitka, L. S. Jr. U. M. (5658).	Starks, Port Ludlow, L. S. Jr. U. M. (5027).	Snyder, Crescent City.	Snyder, Crescent City.	Greeley & Cowles, Pillar Point.	Greeley & Cowles, Pillar Point.	Greeley & Spaulding, Pigeon Point.	Greeley & Spaulding, Pigeon Point.
Extreme length in millimeters	54	44	56	59	61	58	61	58	59
Greatest height of body	14	22	26	26	24	26	23	27	24
Least height of caudal peduncle	8	8	10	10	9	9	9	9	9
Length of caudal peduncle	16	19	18	17	17	16	17	17	16
Length of head	31	32	34	35	33	34	32	34	33
Width of head	24	22	27	24	26	24	24	25	25
Width of interorbital space	5	6	5	5	6	5	5	5	5
Height of head at pupil	16	16	15	15	15	15	14	16	15
Length of snout	9	9	9	9	9	9	9	9	9
Diameter of orbit	6	6	6	7	7	7	6	7	6
Distance from snout to spinous dorsal	30	32	31	32	32	31	30	31	31
Length of spinous dorsal at base	25	24	28	28	24	25	22	26	24
Height of spinous dorsal	10	10	10	13	10	9	10	11	11
Length of soft dorsal at base	42	42	40	44	43	41	42	40	43
Height of soft dorsal	14	14	14	14	14	13	16	14	15
Distance from snout to anal	46	45	50	47	46	57	53	51	48
Height of anal	14	15	15	16	15	14	14	13	13
Length of caudal	23	23	22	24	26	22	23	21	21
Distance from snout to pectoral	33	31	32	34	33	32	32	33	32
Length of pectoral	37	33	34	36	36	34	36	34	35
Distance from snout to ventral	31	30	30	32	32	32	35	32	31
Length of ventral	18	20	19	19	20	19	19	19	18
Number of dorsal spines	8	8	8	8	8	8	8	8	8
Number of dorsal rays	16	17	16	17	17	17	17	16	16
Number of anal rays	13	13	13	13	13	13	13	13	13
Number of pectoral rays	14	14	14	14	14	14	14	14	14
Length of first anal ray, male	17	17	......	20	19	......	17	......	18

Clinocottus analis (Girard).

Oligocottus analis Girard, Proc. Ac. Nat. Sci. Phila. 1857, 201, Monterey; Girard, U. S. Pac. R. R. Sur., x, Fishes, 57, 1858; Jordan & Gilbert, Synopsis, 718, 1883.

Cottus criniger Günther, Cat., II, 522, 1860, Monterey.

Centridermichthys analis Günther, Cat., II, 171, 1860.

Clinocottus analis Jordan & Evermann, Fishes of North and Middle America, II, 2012, 1898.

Body light brown, crossed by seven or eight irregular dark bands, broken anteriorly and covered everywhere with fine white, yellow, and pink spots, occasionally olive in some specimens, and in others uniform white, which may be united in irregular blotches; a faint reddish spot on dorsal fin, another on dorsal side of caudal peduncle; head, dull black, shaded with light brown, and thickly spotted as body; top of head lighter, throat silvery white, with irregular dark-brown and black spots; belly light yellow or white, pectorals and tail barred with broad bands of olive green, and sometimes edged with yellow or red; soft dorsal olive, rays spotted with white and black, and whole fin of breeding males edged with a row of red spots varying greatly in extent, but always conspicuous. Some young specimens have a distinctly reddish tinge over head and dorsal part of body, others are or

a uniform green color, broken only by dark markings, and agree closely in color with the green algæ (*Ulva*), among which specimens exhibiting this type of coloration live.

This is the largest and most common cottoid in the pools of Monterey Bay, and is found everywhere about the bay from low to high water mark, but especially in the shallow exposed pools high up on the coast, which contain almost no algae. Its dull, almost uniform, color agrees very well with the bare rocks and sand. It is much less common at Pillar Point, San Mateo County, where its place is partly taken by *Oligocottus maculosus*. The young have much larger scales proportionally than the adults, and the scales extend forward as far as the origin of the spinous dorsal, while in old individuals these anterior scales have entirely disappeared, and their place is taken by cirri as far back as the soft dorsal, while the posterior scales are greatly obscured.

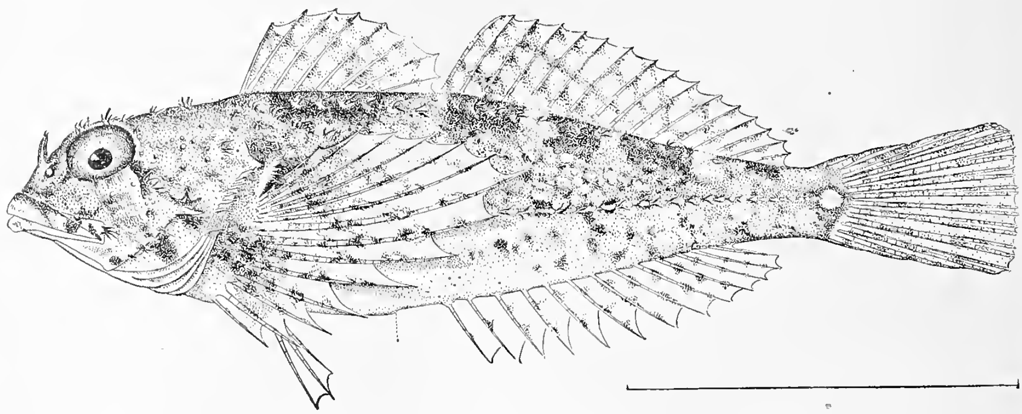


FIG. 5.—*Eximia rubellio* Greeley. Type.

EXIMIA Greeley, new genus.

Allied to *Oligocottus*, but differing in the presence of a large three-pointed preopercular spine instead of the simple forked spine of *Oligocottus*. Skin smooth. A slit behind last gill.

Eximia rubellio Greeley, new species. Fig. 5.

Head 2.83; eye 3.75 in head; snout 3.75; D. VII or VIII, 15 or 16; A. 12 or 13; P. 13 or 14; V. I, 3.

Body compressed, snout pointed and compressed, head deep, occiput narrow, slightly concave; interorbital space narrow, half the large eye, shallowly grooved. Nasal spines prominent, very large, and pointed. Teeth small, pointed, on jaws, vomer, and palatines; jaws equal, mouth horizontal, maxillary 3 in head, reaching a vertical below anterior edge of pupil. Margin of preopercle armed with a very strong spine as long as eye, extending backward and downward, bearing on its upper surface a second and third spine, both pointing back and up; all the spines covered with skin in life; opercle ending in a rounded flap. Branchiostegals 6, not united to isthmus; gills 3½, a slit behind last gill. Anal papilla inconspicuous. Dorsal fins not joined; first dorsal beginning in advance of margin of opercle, first two spines short, upper margin slightly rounded, soft dorsal beginning in advance of origin of the anal; all rays and spines very slender; pectorals reaching well beyond origin of anal; anal fin small, rays slender, membranes emarginated between each ray; in males the first ray enlarged, the second slightly elongated, the two united, and not separated from rest of fin, as in *Dialarchus snyderi;* ventrals situated below upper edge of base of pectorals, just reaching anus. Cirri all distinct, never joined at base in a comb as in *Dialarchus snyderi;* three pairs of bunches of two or three cirri each above orbits, first bunch directly above nasal spines, three pairs on top of head behind orbits, a few scattered cirri below these on sides of head, a bunch of two or three on end of maxillary, a row on lower margin of preopercle, a large bunch above the preopercular spines, and several scattered cirri on margin of opercle; a row of bunched cirri along anterior half of lateral line, a row along base of dorsal, including a bunch of three or four for each spine and ray, the row bending downward at last spine of first dorsal, leaving a space between cirri and base of dorsal spines; a few scattered cirri between dorsal and lateral rows and below lateral line behind pectoral fins.

Color light brown to all shades of light red, pink, or lavender, spotted everywhere with white spots extremely minute on dorsal half of body, but more conspicuous ventrally; five wedge-shaped spots of dark brown along dorsal side of body; head dark brown, sometimes blotched with red or

green, becoming lighter on sides, leaving a dark postocular line extending from eye to preopercular spine and a dark spot on lower margin of preopercle, everywhere very finely marked with white and blue; a white spot with a brown center just in front of first dorsal; throat and belly a very light bluish-green, shading into a faint yellow behind pectorals, and a brownish-green on each side of anal; all the fins, except ventrals, light brownish-green barred with dark brown; caudal light reddish-brown, anal and tip of pectorals tinged with pinkish. A young example is lighter and more brilliantly colored. This species is most closely allied to *Dialarchus snyderi*, from which it differs in presence of a third preopercular spine, greater depth and comparative length of head, larger eye and nasal spines, and arrangement of cirri. Many specimens taken at Monterey Bay, but not recorded from any other locality. The most brilliantly colored of the tide-pool fishes, inhabiting only deep pools rich in plant life.

Comparative measurements of six specimens of Eximia rubellio.

Measurements.	Collectors and localities.					
	Albatross, Monterey, L. S. Jr. U. M. (3642).	McGregor, Monterey, L. S. Jr. U. M. (4048).	McGregor, Monterey, L. S. Jr. U. M. (4048).	Greeley & Maddren, Pac. Gr. (type).	Greeley & Cowles, Pac. Gr.	Greeley & Cowles, Pac. Gr.
Extreme length in millimeters	53	53	52	53	55	45
Greatest height of body	30	28	25	27	27	27
Least height of caudal peduncle	7	7	8	7	8	8
Length of caudal peduncle	16	17	15	14	15	15
Length of head	37	35	36	37	37	37
Width of head	25	28	28	26	28	27
Width of interorbital space	5	6	6	7	6	6
Height of head at pupil	19	18	18	19	20	20
Length of snout	10	10	10	10	10	10
Diameter of orbit	9	8	9	8	8	8
Distance from snout to spinous dorsal	32	32	32	31	33	33
Length of spinous dorsal at base	21	22	24	25	20	22
Height of spinous dorsal	10	11	10	12	10	10
Length of soft dorsal at base	37	41	41	37	39	39
Height of soft dorsal	16	15	15	16	17	16
Distance from snout to anal	57	57	52	54	55	54
Height of longest anal ray	15	15	15	13	13	14
Length of caudal	21	21	21	21	21	21
Distance from snout to pectoral	35	35	34	34	36	36
Length of pectoral	32	32	32	34	34	34
Distance from snout to ventral	36	37	32	32	37	37
Length of ventral	17	18	17	18	18	18
Number of dorsal spines	7	8	8	8	8	8
Number of dorsal rays	15	15	16	16	16	15
Number of anal rays	12	13	13	13	13	12
Number of pectoral rays	13	13	13	14	14	14
Length of first anal ray, male	......	......	......	......	......	18

Artedius lateralis (Girard).

Scorpænichthys lateralis Girard, Proc. Ac. Nat. Sci. Phila. 1854, 145, San Luis Obispo and San Francisco.

Artedius lateralis Girard, Proc. Ac. Nat. Sci. Phila. 1856, 134; Girard, U. S. Pac. R. R. Surv., x, Fishes, 70, pl. 229, figs. 5 and 6, 1858; Günther, Cat., ii, 174, 1860; Jordan & Evermann, Fishes of North and Middle America, ii, 1902, 1898.

Ground color brown, tinged with olive and broken by many white spots below, lower row shading into yellow of ventral side, leaving a scalloped margin; body crossed by several lavender bands, the extent of which is extremely variable, depending on color of algæ; usually a broad band extending from just behind eyes to the middle of first dorsal, and reaching edge of opercle on sides, with two or three less distinct bands behind this; a spot of same color at end of soft dorsal, continued on the two sides; another more distinct spot on base of caudal at end of lateral line; three or four smaller spots along lateral line which embrace a corresponding number of broad lamellæ-shaped cirri, much larger than the rest; a blotch of pink at base of pectorals, with very fine vermiculations of same color on soft dorsal; spinous dorsal reddish; soft dorsal brown, shaded with red and irregularly spotted with

white; under side of throat brown, with fine light spots shading into white posteriorly, and shaded with green, which extends about the inside of the mouth, back of pectorals, and down middle line of belly; sides of belly and ventral side of body on each side of anal yellow.

The most brilliant and sluggish of the tide-pool cottoids, usually lying close to the rocks and rarely moving rapidly. Distinguished from *A. asperulus* by the shape and depth of head and length of the band of scales, and not by number of rows in the band. A number of my specimens have nine rows, and are identical in this respect with *A. asperulus*. *A. lateralis* occurs in all kinds of tide-pools, high or low, but is usually found singly, and never are there many in the same pool. These solitary habits differ very noticeably from those of the other tide-pool cottoids in their strikingly social manner of life.

Caularchus mæandricus Girard.

Lepidogaster reticulatus Girard, Proc. Ac. Nat. Sci. Phila. 1854, 155, San Luis Obispo, Cal.; name preoccupied.

Lepidogaster mæandricus Girard, Pacific R. R. Surv., x, Fishes, 130, 1858, San Luis Obispo, Cal.; substitute for *reticulatus*, preoccupied in *Ledadogaster;* Günther, Cat., III, 505, 1861.

Gobiesox reticulatus Jordan & Gilbert Synopsis, 749, 1883.

Caularchus mæandricus Jordan & Evermann, Fishes of North and Middle America, III, 2328, 1898.

Color yellowish green, with faint vermiculations of brown, and spots of clear yellow more apparent on top of head; a distinct interorbital line of same color; tip of snout tinged with black; dorsal, anal, and caudal light-brown, edged with bluish-white.

The only fish of this family (*Gobiesocidæ*) found in tide-pools of Monterey Bay and northward.

Gibbonsia elegans (Cooper).

Myxodes elegans Cooper, Proc. Cal. Ac. Sci., III, 109, 1864, San Diego and Santa Barbara.

Clinus ocellifer Mocquard, Bull. Soc. Philom. Paris, 1886, 44, California.

Clinus evides Rosa Smith, Proc. U. S. Nat. Museum 1883, 235, specimens from Todos Santos; not of Jordan & Gilbert.

Gibbonsia elegans Jordan & Evermann, Fishes of North and Middle America, III, 2353, 1898.

Originally described from Point Loma and its geographical range given as from Point Concepcion south to Todos Santos. In 1883 Jordan & Gilbert described *G. evides*, ranging from Point Concepcion northward. The two nominal species were distinguished as follows by Jordan & Evermann:

G. evides: Dorsal V–XXXI, 10; anal II, 26; soft dorsal low; coloration comparatively plain, the soft dorsal without pellucid area.

G. elegans: Dorsal V–XXVIII, 7; anal II, 24; soft dorsal high; coloration more or less variegated, soft dorsal with a high pellucid blotch posteriorly.

My collection from Monterey Bay contains some specimens which are undoubtedly *G. elegans*, thus extending the range of that form to Monterey Bay. Others are exactly intermediate between the two species, with some of the characteristics of one and some of the other, thus indicating that these two species are not really distinct. The characters of these intermediate forms are:

Dorsal V–XXX, 9; anal II, 26; a small pellucid spot on soft dorsal; coloration brilliant black with longitudinal yellow bands.

Dorsal V–XXX, 8; anal II, 27; a large pellucid spot on soft dorsal; color light reddish-brown, crossed by narrow bands of dark brown; fins yellowish, barred with brown.

Dorsal V–XXIX, 8; anal II, 25; a large pellucid spot on soft dorsal; coloration perfectly plain.

Dorsal V–XXX, 9; anal II, 28; small pellucid spot on soft dorsal; coloration perfectly plain.

I find similar intergradations in specimens from San Diego. It appears that the two forms can not be distinguished at any point throughout their range. The number of fin rays and the coloration will not serve to separate the species; therefore *G. evides* must be identical with *G. elegans*, which has the priority of description.

1. SYNAPTA ROSEOLA (VERRILL). NATURAL SIZE.
2. A PART OF THE SAME MAGNIFIED FOUR TIMES.
3. SYNAPTA INHAERENS (O. F. MÜLLER). NATURAL SIZE.

Contributions from the Biological Laboratory of the U. S. Fish Commission
Woods Hole, Massachusetts.

THE SYNAPTAS OF THE NEW ENGLAND COAST.

By HUBERT LYMAN CLARK,
Professor of Biology, Olivet College, Michigan.

Through the kindness of the United States Commissioner of Fish and Fisheries special opportunities were enjoyed during the spring and summer of 1898 for carrying on biological investigations at the laboratory of the Fish Commission at Woods Hole, Mass. The few weeks at my disposal were devoted to the study of the two holothurians of the genus *Synapta* common at that place. Primarily the object in view was to determine the systematic position of our New England synaptas, their relation to each other and to European forms. At the same time experiments were carried on designed to throw light on the function of certain organs and on the possibilities of regeneration in *Synapta*. The latter were, however, limited by the shortness of my stay.

For the privileges of the laboratory I desire to express my thanks to the Commissioner, and particularly to the director of the laboratory, Prof. H. C. Bumpus, whose constant kindness and sympathy made the work doubly pleasant. I desire also to acknowledge my indebtedness to Mr. Charles M. Pratt, of New York City, for a very fine lot of synaptas from Naples, without which the relation of the American to the European species could not have been positively determined.

THE SYSTEMATIC POSITION OF THE NEW ENGLAND SYNAPTAS.

On February 5, 1851, at a meeting of the Boston Society of Natural History, Mr. W. O. Ayres ('51) described under the name *tenuis* a synapta which he had found abundantly in Boston Harbor and also at Provincetown, Mass., and Sag Harbor, Long Island. He separated it from the European species on account of slight differences in the "hooks" and "plates." How little the anatomy of the animal was understood is shown by the description of the calcareous ring which he says consists "of 12 pieces of granulated structure, some of which are pierced with holes for the admission of water in respiration." The same year Pourtales ('51) read a paper at the meeting of the American Association for the Advancement of Science, in Cincinnati, "On the Holothuriæ of the Atlantic coast of the United States," in which he described the common New England synapta under the name *girardii*, but he says that the only differences he can find between it and the European *S. inhærens* (O. F. Müll.) are that the anchors are less curved and the plates more rounded. He seems to have been unacquainted with Ayres's paper, which was presented three months before his own.

In 1867, Verrill ('67) refers to our common synapta under the name of *tenuis*, and proposes to make it the type of a new genus *Leptosynapta*, "distinguished by their more slender form, the absence of prominent verrucæ, fewer (12), shorter, and more

digitate tentacles, etc.," from "the typical species of synapta," which "have 15 tentacles and prominent verrucæ." This proposed genus has not been accepted by any writer on holothurians, because the form of the body and the prominence of the verrucæ are so closely connected with the degree of contraction of the muscles that they are virtually worthless as characters, while the number and shape of the tentacles differ in different species to such an extent that generic distinctions can not be based exclusively on them. Since Verrill proposed his genus *Leptosynapta* three species of synapta with normally 13 tentacles, one with 11, and two with 10 have been described, and species with 20 and 25 are also known. Doubtless the genus *Synapta* as at present constituted includes two or more natural genera, but Verrill's genus *Leptosynapta* is not sufficiently well characterized to stand. The same year in which this change was proposed saw the publication of Selenka's ('67) well-known monograph on the Holothurians. He pointed out that the name *tenuis* had been used for a synapta by Quoy & Gaimard in 1833, and accordingly suggests *ayresii* as a name for the form Ayres had called *tenuis*. He gives *girardii* Pourtales as a form from Cape Florida, evidently having read the original description hastily or carelessly, and he entirely overlooks its similarity to *tenuis* Ayres. In addition, he describes a species *gracilis* from Boston Harbor, which, as Théel ('86) has pointed out, is obviously based on specimens of *tenuis* Ayres, in which the calcareous bodies have evidently undergone some change due to the alcohol or other preservative used.

In 1874, Verrill ('74) gives the common New England synapta the name *Leptosynapta girardii*, accepting Selenka's objection to the name *tenuis* and recognizing the fact that Selenka's names *ayresii* and *gracilis* are but synonyms of Pourtales's name *girardii*. At the same time he gives a very brief and hasty description of a species of synapta from the New England coast which he calls *Leptosynapta roseola*. Thirteen years later Lampert ('85) gives *gracilis* Sel. the rank of a good species, but places *tenuis* Ayres, *girardii* Pourt., and *ayresii* Sel. as synonyms under *S. inhærens* (O. F. Müll.). He ignores Verrill's *roseola* altogether, not even giving it the place of a synonym, though in his literature list he gives Verrill's paper (1874) as containing the description of one new synapta. The following year Théel ('86) placed the names *tenuis* and *girardii* in the list of synonyms of *inhærens*. He says of Selenka's *gracilis* that it "seems very doubtful; doubtless identical with *inhærens*," and of Verrill's *roseola*, "doubtless not a distinct species." The very best authority on the group, Ludwig ('92), gives *gracilis* Sel. and *roseola* Ver. as good species, but ignores *tenuis* Ayres, *girardii* Pourt., and *ayresii* Sel., apparently regarding them as synonyms of *inhærens*.

American zoologists have generally followed Verrill in recognizing two American species of synapta, both distinct from the European species, and the names *Leptosynapta girardii* and *Leptosynapta roseola* have been in common use in this country. European zoologists, on the other hand, have generally credited us with but a single species, and that one identical with the common European form, *inhærens*. A careful comparison of numerous specimens convinces me that truth lies between these two positions. American zoologists are right in supposing we have two species, but European writers are correct in considering *girardii* identical with *inhærens*. The identity of the two forms seems to me to be beyond question, for there are absolutely no constant differences in either the gross or microscopic anatomy. A comparison of anchors and plates, both in size and shape, shows that while the individual differences may be great, they are entirely inconstant, and I could not find a single point by which the specimens from Naples could be distinguished from those collected at Woods Hole.

The name and synonymy of the common white synapta of the New England coast are therefore:

Synapta inhærens, (O. F. Müll.), Zool. Dan. 1779–1784.
Synapta tenuis, Ayres, Proc. Bos. Soc. Nat. Hist., vol. IV, p. 2.
girardii, Pourtales, Proc. Am. Ass. Ad. Sci., 1851, p. 14.
ayresii, Selenka, Zeit. f. wiss. Zool., 1867, vol. XIV, p. 362.
gracilis, Selenka, Zeit. f. wiss. Zool., 1867, vol. XIV, p. 363.
Leptosynapta tenuis, Verrill, Trans. Conn. Acad., vol. I, p. 325.
girardii, Verrill, Rep. on Inv. Ani. of Vineyard Sound, p. 422.

The status of Verrill's *Leptosynapta roseola* is quite different, and I believe that it must be accepted as a valid species. In living specimens there is never the slightest difficulty in distinguishing between *roseola* and *inhærens*. I have never seen but one specimen in which the color alone was not sufficient to distinguish them, and in that specimen even a very superficial examination showed that it was *roseola*. Alcohol makes the color differences even more marked, so that in preserved material the two species are very easily separated. But there are three points in the microscopic anatomy of *roseola* which serve to distinguish it readily from *inhærens*, and on these three points its claim to good standing as a species must rest:

(1) The most important point is found in the radial plates of the calcareous ring. In *inhærens* these plates are about three-fourths as high as broad, and each is perforated through the center for the passage of the radial nerve. In *roseola*, on the other hand, the radial plates are only about half as high as they are wide, and they are *not* perforated, *the radial nerve passing over the top of each in a shallow notch*. At first I thought this was simply a stage of development in the formation of the plate, but I was finally convinced that such could not be the case. No specimen of *inhærens*, however small and immature, had a radial plate which was not distinctly perforated through the center, and no specimen of *roseola*, however large, showed any condition beyond the notch. The differences in the calcareous ring are shown in figs. 1 and 2, plate 11.

(2) The calcareous spicules of the body wall present the second distinguishing characteristic of *roseola*. In form, proportions, and distribution of anchors and plates I could find no constant differences between the two species; and Verrill errs in saying that in *roseola* "the perforated plates are smaller and the anchors relatively much longer, with a very slender elongated shaft." Careful measurements, with the aid of a camera lucida, of a large number of anchors and plates taken at random in specimens of *roseola* and *inhærens* from Naples and from Woods Hole, gave the following results:

Species and locality.	Length of anchor.	Breadth of shaft.	Ratio of breadth to length.	Length of arms.	Ratio to length of anchor.	Breadth of arms.	Ratio to length of anchor.	Length of plate.	Ratio to length of anchor.	Breadth of plate.	Ratio to length of anchor.
Inhærens, Naples....	177 μ	17+ μ	.10	44 μ	.25	83 μ	.47	131 μ	.77	100 μ	.56
Inhærens, Mass	164	17+	.108	49	.30	92	.56	135	.82	93	.57
Roseola, Mass	142	16	11	38	.27	76	.53	115	.81	72	.57

μ Abbreviation for micron.

In a still larger series:

Species and locality.	Average length of anchor.	Average length of plate.	Ratio of plate to anchor.
Inhærens, Naples..................................	179 μ	133 μ	.74
Inhærens, Massachusetts..........................	177	139	.78
Roseola, Massachusetts..........................	164	131	.79

It would be absurd to attempt to make any specific character dependent on such slight differences, but in the other calcareous particles in the body wall, *roseola* differs markedly from *inhærens*. In the skin of the tentacles, especially on their inner side, we find in *inhærens* some small, simple particles, not at all branched (fig. 3). In *roseola* these particles are more numerous and are always very much branched and perforated (fig. 4). In the longitudinal muscles of *inhærens* are numerous small, round, or sometimes dumb-bell shaped, particles; they are never branched or perforated (fig. 5). In *roseola* the concretions of the longitudinal muscles are either C-shaped or perfect circles; more rarely they are somewhat branched (fig. 6). These differences, though seemingly slight, are remarkably obvious and constant and no signs of intergradations were found.

(3) The third characteristic of *roseola* is found in the size and shape of special ciliated funnels. In both species these large ciliated funnels seemed to be confined chiefly to the mesentery of the left dorsal interradius and occur singly every millimeter or two. Semon ('87) speaks of two sorts of ciliated funnels in *digitata*, but he does not seem to have observed them in *inhærens*. In the latter species the large funnels are from 400μ to $1{,}200\mu$ high, and from 150μ to 400μ in diameter. Their shape is shown in fig. 7. In *roseola* they are smaller and much more slender, measuring less than 300μ high and 80μ in diameter (fig. 8).

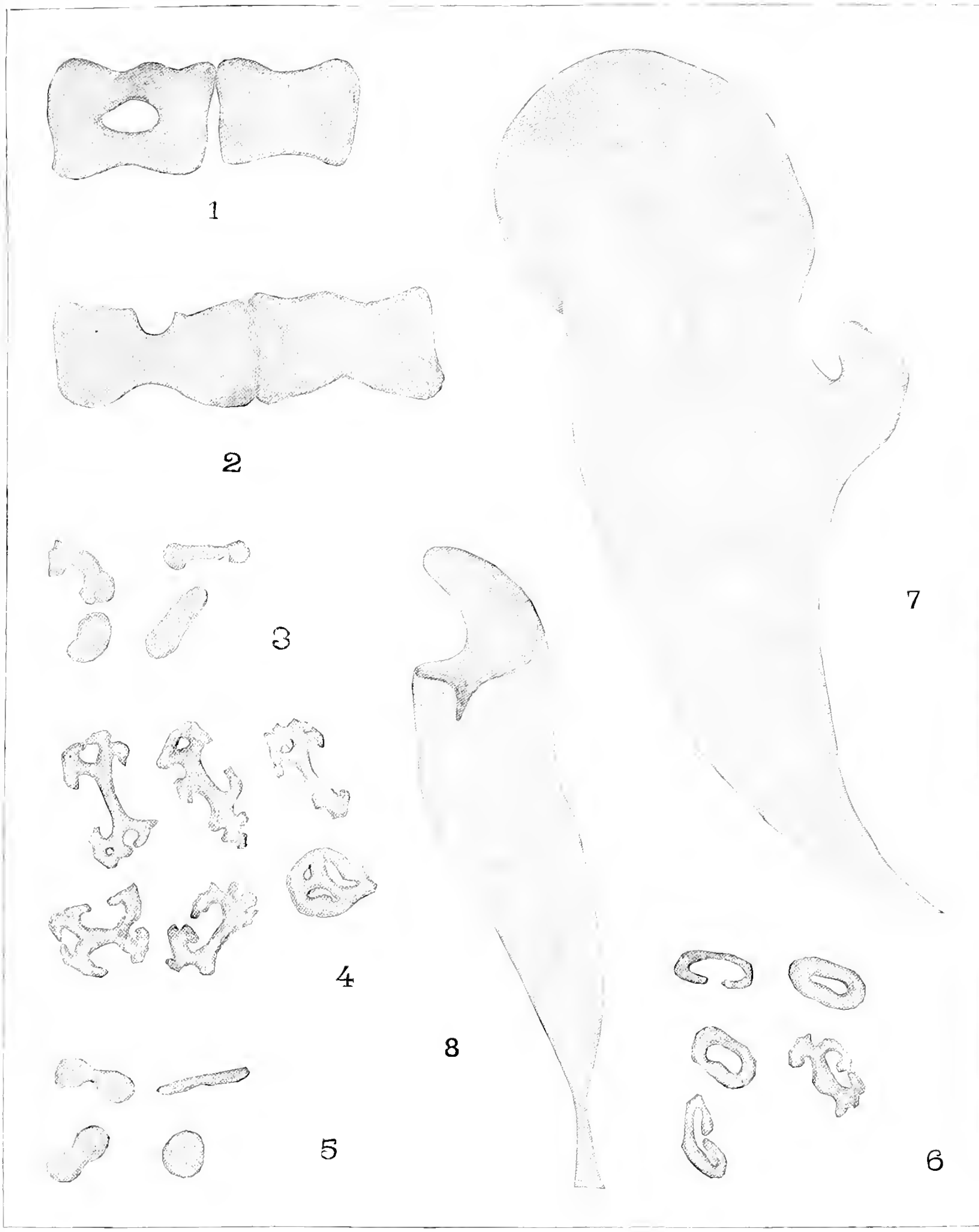
In addition to these points of anatomy, there are noticeable differences in habitat between the two species; *inhærens* occurs in sand or sandy mud, or even in pure mud, less commonly along gravelly shores; *roseola* occurs on rocky or gravelly shores under stones or among the pebbles, and never in pure sand or mud. I have never found *roseola* except where there was sufficient iron present in the soil to give it a decidedly rusty color, and it has occurred to me that there might be some connection between the very unusual amount of pigment developed in *roseola* and this excess of iron. Some specimens of *inhærens* show more or less pigment when carefully examined, and several specimens among those received from Naples were as rosy in color as the average *roseola*, but none of them show any approach to that species either in the calcareous ring, the concretions in the body wall, or the large ciliated funnels. Until intergradations are shown and some better explanation is offered of the constancy with which these characters separate *roseola* and *inhærens*, it seems to me they must be regarded as distinct species. As Verrill's description of *roseola* is so incomplete and is also erroneous, I venture to give the following summary of its characters:

Synapta roseola (Ver.).

Leptosynapta roseola, Verrill. Rep. on the Inv. Ani. of Vineyard Sound, 1874, p. 422.

Synapta roseola, (Ver.), Théel. Report of the *Challenger*, The Holothurians, vol. XIV, 1886, pt. XXXIX, p. 25.

More slender than *inhærens* and general appearance much more soft and delicate; usually much smaller, rarely exceeding 100 mm. in length, even when extended. Body wall white or colorless, thin, but thickly covered with verrucæ, which contain numerous pigment granules of a reddish color, giving a generally bright rosy color to the animal. The pigment resembles that found in *S. digitata* (Mont.) (see Semon, '87) in that it is scarcely at all bleached by alcohol even after months, but it is entirely destroyed by acids or corrosive sublimate. Rarely the body wall is yellowish or pale buff, making the general effect reddish-yellow. Tentacles 12, each with 2 or 3 (rarely 4) pairs of digits and with 7 to 15 sensory cups on the inner side. Genital glands much branched, and when filled with the sexual products very conspicuous through the pink skin. Polian vessel generally single. No cartilaginous ring. Calcareous ring narrow, the radial pieces not perforated for the passage of the nerves, but simply notched on the upper edge. Ciliated funnels numerous, of two kinds; the largest ones, measuring about 300μ high by 60μ in diameter, infrequent, confined almost exclusively to the left dorsal mesentery; the smaller ones measure hardly one-fourth as much in height but



EXPLANATION OF PLATE

1. Part of calcareous ring of *Synapta inhærens.* 45 ×.
2. Part of calcareous ring of *Synapta roseola.* 45 ×.
3. Calcareous particles from the tentacles of *S. inhærens.* 450 ×.
4. Calcareous particles from the tentacles of *S. roseola.* 450 ×.
5. Calcareous particles from the longitudinal muscles of *Synapta inhærens.* 450 ×.
6. Calcareous particles from the longitudinal muscles of *Synapta roseola.* 450 ×.
7. Large ciliated funnel of *Synapta inhærens.* Seen from behind. 125 ×.
8. Large ciliated funnel of *Synapta roseola.* Seen from in front. 337 ×.

nearly as much in diameter. Anchors and plates not essentially different from those of *inhærens*. Calcareous rods in the sides of the tentacles and in the digits slightly curved and knobbed as in *inhærens;* besides these, numerous branched, curved, and perforated rods and plates occur abundantly on the inner surface near the base of the tentacles. Calcareous particles in the longitudinal muscles C or doughnut-shaped, rarely branched.

This species occurs between high and low water mark in gravelly banks or on rocky beaches, where there is considerable iron in the soil. Usually found near the surface and often underneath rocks.

PHYSIOLOGICAL NOTES.

Contrary to previous experience and to several writers on holothurians, I found during the summer of 1898 that *Synapta inhærens* is very easy to keep in aquaria and *roseola* is about as hardy. On account of the greater abundance and larger size of the former, most of my observations were made on that species. When left in a vessel containing sea water only, the synaptas crawl about restlessly on the bottom, and unless fresh sea water is supplied they soon begin to constrict off parts of the body, beginning near the posterior end, and after a time nothing but small pieces will remain, and these soon die. If the supply of sea water is abundant and well aërated, this process may be delayed some hours, but it usually occurs in less than half a day. When, however, there is a sufficient amount of clean sand in the dish to allow the animals to burrow at will, they will live indefinitely if the supply of water is constantly renewed. By filling glass jars half full of sand, one is able not only to keep synaptas alive, but to study more or less of their underground habits. I agree entirely with Cuénot ('91) in believing that autotomy is not normal or defensive, but is due entirely to pathological conditions. I never saw a case of it in synaptas supplied with plenty of sand and an abundance of sea water. The fact that portions constricted off can not live is good reason for supposing the process is abnormal. An excess of magnesium sulphate in the water causes stupefaction and ultimate death, so that excellent specimens, either for laboratory purposes or for the cabinet, may be obtained by narcotizing with this salt and killing in strong alcohol or corrosive sublimate.

Both species of synapta breed during the spring and early summer. The sexual glands are well developed by the last of April, and individuals with ripe ova may be found well into August. About the last of June or early in July seems the height of the breeding season at Woods Hole. Personally I have had no success with artificial fertilization of the eggs, but Dr. W. R. Coe, of Yale University, states that he has found no difficulty in fertilizing the eggs of *S. roseola* artificially, though he has made no attempt to carry their development beyond the segmentation stages. In that species the ripe genital glands show plainly through the body wall, and individuals in which the male elements fill the glands are easily distinguished from those in which the ova are mature. Further investigations into the breeding habits and embryology of our two synaptas are very much to be desired.

Synaptas burrow into the sand head first and almost always go straight downward for some distance, but when once completely buried, they turn in any direction up or down or on the horizontal plane. They can and do turn in their burrows, but as a rule they make new tubes when they come to the surface. They are seldom still, and the old idea that they remained in the tube they have formed with their tentacles just above the surface is scarcely true. Sometimes they assume that position, but seldom remain so very long. They rarely leave their burrows and come out on the surface of the sand, and I doubt if they ever do so under normal conditions.

Passage through the sand is chiefly accomplished by means of contractions and extensions of the body, but is materially assisted by the tentacles. With the latter,

which are almost continually in motion, the sand is loosened and the grains more or less separated. By the contraction of the longitudinal muscles the rear of the body is brought up nearer to the head, and then the circular muscles contract and extend the body again. It is prevented from slipping back by the anchors, which are elevated by the contraction of the circular muscles and hold against the sand. Since the contraction begins next to the rear end and moves forward, the head end is pushed onward, the anchors there lying flat in the skin.

This process of alternate contractions of the two sets of muscles is very obvious to an observer, and takes place very continuously, though not rapidly. In this way a synapta can move through the sand from 2 to 3 centimeters a minute, and an *inhærens* of average size can get entirely out of sight in 5 or 6 minutes. One of the most remarkable provisions for the use of the anchors in locomotion is *their much greater abundance and their considerably greater length in the posterior part of the body.* The use of this is clear when one realizes how the rear of the body acts as the resisting base against which the muscles work in pushing the anterior end forward. This difference between the anchors of the anterior and posterior ends of the body seems to have been overlooked hitherto, so great an authority as Ludwig ('98) saying of *inhærens* "Anker und anker platten differieren in vorderen und hinteren körperabschnitt nicht merklich von einander." In the same paper, however, he calls attention to the fact that in *S. digitata* the anchors of the posterior end of the body are about 50 per cent longer than those in the anterior end. While the difference in *inhærens* is not quite so great as that, yet it is very noticeable, being above 33 per cent. In both species there is an increase also in the length of the plates, but, as would naturally be expected from the passive part they play, it is not nearly as great. The following figures will bring out the condition in *inhærens* very plainly. A specimen 14 cm. long was chosen at random and cut into seven approximately equal pieces, and in each piece 10 anchors and plates, selected entirely at random, were measured with these results, No. 1 being the most anterior, No. 7 the farthest back; measurements are all in microns:

	No. 1.		No. 2.		No. 3.		No. 4.		No. 5.		No. 6.		No. 7	
	Average length of anchor.	Average length of plate.	Average length of anchor.	Average length of plate.	Average length of anchor.	Average length of plate.	Average length of anchor.	Average length of plate.	Average length of anchor.	Average length of plate.	Average length of anchor.	Average length of plate.	Average length of anchor.	Average length of plate.
Number	141	124	153	134.5	162.5	135.6	164	138	202	157	204	145	197	135
Ratio of plate to anchor	......	.88	.....	.87	....	.83	......	.84	.....	.75	......	.71	......	.68
Per cent increase in length	.....	.....	.09	.08	.06	.008	.009	.017	.23	.14	.009	—.077	—.03	—.07
Maximum length of anchor in each section	155		171		178		197		220		220		224	

The most striking feature of this table is the abrupt and marked increase in the size of both anchors and plates in the fifth section. The average length of anchors for the first four sections is 155μ; of plates, 133μ; ratio = 86 per cent. For the last three, 201μ is the average length of the anchors, 144 of the plates, and the ratio = 71 per cent. That is, the anchors increase 29 per cent and the plates 8 per cent. The slight decrease in the last section is probably due to the fact that comparatively little strain could be brought upon the anchors situated so very near the tip of the body, but it is noticeable that the longest anchor of all was found in that section. The

increase in the length of the anchors of the last two sections over those of the first one is over 40 per cent.

In two other specimens of *inhærens* and one of *roseola*, also selected at random, the following measurements in microns were made:

Measurements taken.	Inhærens.		Roseola.
Length of longest anchor anteriorly	160	160	151
Length of longest anchor posteriorly	226	249	195
Percentage of increase in length of anchors	41	56	29
Length of longest plate anteriorly	144	131	125
Length of longest plate posteriorly	169	178	153
Percentage of increase in length of plates	17	36	22
Average length of anchors anteriorly	149	140	142
Average length of plates anteriorly	134	121	118
Ratio of plates to anchors anteriorly	.90	.86	.83
Average length of anchors posteriorly	200	220	188
Average length of plates posteriorly	148	156	145
Ratio of plates to anchors posteriorly	.74	.70	.77
Percentage of increase in average anchor's length	33	57	38
Percentage of increase of average plate's length	10	29	23

These figures prove conclusively that the anchors at the posterior end of the body are from 30 per cent to 40 per cent longer than those near the head, while the plates only increase 10 per cent to 25 per cent, and, consequently, there is a decided drop in the ratio between anchors and plates in the two regions.

Now, in regard to the relative abundance of anchors and plates anteriorly and posteriorly, the following figures show that not only are the anchors shorter near the head but they are decidedly less frequent:

Species.	Average number of anchors per sq. mm. anteriorly.	Average number of anchors per sq. mm. posteriorly.	Pecentage of increase.
Inhærens	10.3	14	36
Do	6.8	11.2	65
Roseola	12	23.6	96
Average of a large series	9.8	15.6	59

There does not seem to be any distinction in the size or abundance of the anchors between the dorsal and ventral surfaces of the animal.

Semon ('88) has expressed the opinion that synaptas are not subterranean in their mode of life, and he bases his opinion largely on the color of *S. digitata.* The question, however, does not admit of debate so far as *inhærens* and *roseola* are concerned, for not only do they never appear normally on the surface of the sand either along shore or in aquaria, but the arrangement of the anchors just described could only be of much practical service in a close-fitting burrow. The whole structure of the animal shows modification adapting it to underground life and the increase in size and number of the anchors posteriorly is one of the most interesting. When placed in a glass dish without sand, synaptas soon cease to contract the muscles of the body wall but drag themselves slowly along by means of the tentacles, thus showing that the anchors are of little use on a smooth surface. In crawling by means of the tentacles, the glandular *outside* of the tentacle tips and digits is used, so that many of the tentacles are

continually twisted around, making the process appear somewhat awkward. When in their tubes, however, the outer side of the tentacles would be most naturally used, and it is by their adherence to that side of the tentacles that particles of food and sand are brought to the mouth. This use of the outer side of the tentacles in locomotion was observed by Pourtales ('51) in the synapta from Florida, which he called *S. viridis.*

The New England synaptas seem to have organs of special sense of two kinds, olfactory and equilibratory or positional; no evidence of ability to distinguish between light and darkness could be detected and there are no anatomical structures to which this sense could be ascribed. The sense of smell is centralized in the cups on the inner side of the tentacles; that of position in the so-called "otocysts" or "auditory" organs. Semon ('87) has shown that *S. inhærens* possesses the sense of smell, and similar experiments made at Woods Hole confirm his results. If a piece of any rank-smelling substance is placed near the tentacles of a synapta they are immediately retracted and the head is turned away. Small bits of decayed starfish were used and it was found that the synaptas would avoid them even when they did not actually touch them, and they seemed to avoid sand with which decayed starfish had been mixed. While the experiments were not conclusive by themselves, they were satisfactory as confirmation of Semon's work.

In regard to the so-called "otocysts" more numerous and more careful experiments were made, with results which seem to show conclusively that these organs are used to show the position of the animal in the water or sand. Semon ('87) has demonstrated the fact that synaptas appear to have no sense of sound and no ability to detect even strong vibrations in the water. He, however, left the function of these "otocysts" undetermined, but in a previous paper (Clark, '98) I suggested that in *S. vivipara* they determined the animal's position in the water. Experiments on *inhærens* and *roseola* have fully confirmed this opinion and there can no longer be any doubt that this is their true function. In regard to their structure there is little to be added to Semon's ('87) description, as it has not yet been possible to demonstrate the cilia which line them. That they are lined with cilia, which are in constant motion, can be easily seen in the living animal under the microscope. The single vesiculated cell or "otolith" which each "otocyst" contains may be seen to be constantly revolving and never actually rests against the wall of the sac, but is kept out from it, apparently, by these cilia.

Cuénot ('91) in his description of these organs says that there are "un grande nombre d'otolithes spheriques" in each "otocyst," and Semon ('87) says there are one or more (often six or more) "bläschen" in each sac. I have examined a large number of living specimens of both *inhærens* and *roseola* and I have never yet found a case where there was more than *one.* Whether these so-called otoliths are calcareous, as Cuénot thinks, or vesiculated cells filled with fluid, as Semon says, I have not been able to determine positively, though I incline to the latter view, as they do not appear calcareous when compared either by transmitted or reflected light with any undoubtedly calcareous body. But there can be no doubt that they are heavier than the fluid which surrounds them in the sac, as may be readily shown by the following simple experiment: If a pair of the sense organs are cut from a living synapta and placed under a cover-slip and examined under the microscope, the otolith will be seen in the center of the sac so long as the slide is perfectly horizontal. But if the microscope be tipped, so that the slide approaches a perpendicular position, the otolith will be seen to sink slowly to the lower side. (Owing to the reversal of upper and lower sides under the

microscope, of course the otolith appears to rise.) If the slide be turned around slowly the otolith keeps constantly at the lowest point, though kept out from the wall and in motion by the cilia.

In the case of *S. vivipara* I expressed the opinion that this otolith or vesiculated cell *floated* in the liquid and by touching the cilia or sensory hairs at the *highest* point gave rise to sensations of changed position. Now I am convinced that the inclosed cell does not float at all but always rests upon the cilia at the lowest point, thus arousing new sensations with every change of position. That the animal is affected by change of position was proven by the following experiment: Synaptas were placed on a piece of thin board which sloped sharply to the bottom of a dish of sea water. They always sought the bottom of the dish, no matter in what position they were placed on the board. Not a single instance occurred of the animal crawling upward. A single synapta was placed on the board and after it was well started on its way down the slope the board was very gently reversed so that the lower end became the higher. As soon as the board passed beyond the horizontal plane the synapta would stop and as the slope became greater it would turn and start back in the opposite direction, and every change in the slope of the board caused a reversal of direction in the movement of the synapta. This experiment was tried a number of times and on different individuals, but with unvarying results. The change in the position of the board was accomplished with the least possible disturbance of the water, and no one who saw the actions of the synaptas could doubt that it was the change of position which caused the change in the movement of the animal. In the light of these facts and the entire absence of any evidence to show that sound vibrations of any sort can be detected by these or any other organs, it would seem out of place to speak of them as "auditory" organs or even as *otocysts*, and I suggest the name *positional organs*.

A number of experiments were made to determine if possible the function of the ciliated funnels, and while the results were not entirely satisfactory they throw some light, I think, on the use of these curious organs. A large amount of carmine was thoroughly mixed with clean sand and, after it had settled and fresh sea-water had run over it for a little while, half a dozen specimens of *inhærens* were placed in the dish. They lived in the brightly colored sand for one week and were then washed and killed. They showed a very decided pink tinge, which was due only in a very slight degree to the carmine attached to the skin externally. Microscopic examination showed that in the connective tissues there were numerous reddish-brown granules and these were most abundant near the lines of ciliated funnels. No such granules were ever found in synaptas living in sand free from carmine.

While this experiment seemed to indicate that carmine taken in with the sand was in some way absorbed and formed the granules, it does not show that the ciliated funnels were in any direct way connected with the process. Accordingly another line of experiments was begun, carmine mixed with sea-water or the body-cavity fluid of other synaptas being injected directly into the body cavity by means of a fine canula through the body wall. Synaptas so treated were then killed at intervals of about twenty-five minutes for two or three hours, and then at intervals of several hours up to twenty-four. It was found that in a very few minutes the carmine began to gather along the lines of funnels and in a shorter or longer time, according to the individual synapta, the body would resume its normal more or less transparent whiteness, except along those lines which appeared as dark-red longitudinal stripes. An examination

under the microscope showed that the funnels were actually choked up by the excess of carmine, sometimes being almost buried in it. After a few hours these dark-red lines became less prominent and in a few days they generally were completely obliterated.

Microscopic examination of the various stages showed plainly that the ciliated funnels were very closely concerned with this change, and that with the disappearance of the carmine from the body cavity the reddish-brown granules appeared in the connective tissue. In spite of careful study and long search I was never able to discover a grain of carmine or one of the granules actually *in* the stalk of the funnel, yet in some way the carmine must pass from the inside of the funnel into the body wall. Since it is an undoubted fact that the stalk of the funnels is solid and not a tube, the only way by which particles could be conveyed from the cavity of the funnel into the connective tissue would be by means of "wandering cells," and I believe that is the process which actually goes on. Semon's ('87) view of the funnels, as "grosse und complicirt gebaute Lymphstomata der Leibeshölhe," seems to me a correct one, and I believe they perform their excretory function not only by sweeping up and collecting the waste matter in the body-cavity fluid, but also, as Semon suggests, by acting as starting-points for the movement of "phagocytic" wandering cells which destroy or carry into the connective tissue of the body the waste matter collected by the funnels. It seems to me that in view of these facts the ciliated funnels are evidently associated with the function of excretion and it is proper to regard them as excretory organs. Cuénot ('91) considers that their function is to keep up currents in the body-cavity fluid, but every movement of the animal starts new currents so that special organs for that purpose would be superfluous.

A number of experiments were made to test the tenacity of life and the possibility of regeneration in synaptas, and the results show that *inhærens* is not a very sensitive animal. If an individual is cut in two the anterior end will live and grow as well apparently as any normal specimen, but the posterior end will only live for a few hours, or perhaps a day. So far as I could see, the only reason for its death was its inability to take in food; and I am inclined to think that if food could be provided the posterior half would live as well as the anterior. It seemed to make no difference whether the bisection occurred near to the head or far from it; the head always lived, and in the course of two weeks would show perceptible signs of growth. All that seemed to be necessary was the mouth and a small part of the digestive tract. That it was not the tentacles which were essential was shown by the fact that synaptas lived all right without them. Two or more tentacles were cut from a number of synaptas—in two cases every one being removed—yet they all lived and burrowed in the sand with more or less ease; and not only did they live, but regeneration began at once, so that in two weeks the new tentacles were large enough to bear a digit on each side. At first I thought the nerve ring was the essential part, but that seems to be doubtful, for the nerve ring was carefully and completely severed in a synapta without apparently causing any inconvenience. In other specimens it was cut in two or even three places, but with the same result. In no case were any serious effects shown, and the animals lived and burrowed in the sand with apparently as much ease as ever. I made no microscopical examination to show whether the nerve ends reunited or not, but the cuts apparently healed in a short time. The most striking fact was that with the cutting of the nerve ring there was not the least evidence of any lack of coördination in the movements of the tentacles, nor of the muscles of the body.

CONCLUSIONS.

For the sake of clearness and conciseness the results of these investigations may be summarized as follows:

1. The common white synapta of the New England coast is *S. inhærens* (O. F. Müll.). *S. girardii* Pourt. and *S. tenuis* Ayres are synonyms of that species.

2. Verrill's genus *Leptosynapta* can not stand.

3. There is a second species of synapta found in suitable places along the New England coast easily recognized by its reddish color, *S. roseola* Ver.

4. *S. roseola* Ver. differs constantly from *S. inhærens* in the calcareous ring, the deposits in the tentacles and longitudinal muscles, and in the large ciliated funnels.

5. There are no important differences between the anchors or the plates of the two species.

6. The anchors are of real use to the animal in moving in its burrow, and those at the posterior end are most so. Accordingly we find they are there longer, larger, and more abundant.

7. The so-called otocysts are *not* auditory but are undoubtedly positional organs.

8. They never contain but a single otolith.

9. The sensory cups on the tentacles are seemingly olfactory organs.

10. The ciliated funnels are large and complex lymphstomata and may properly be called excretory organs.

11. Regeneration takes place readily and rapidly in synaptas where the mouth and part of the adjacent digestive tract are left intact.

AMHERST COLLEGE,
Amherst, Mass., October, 1898.

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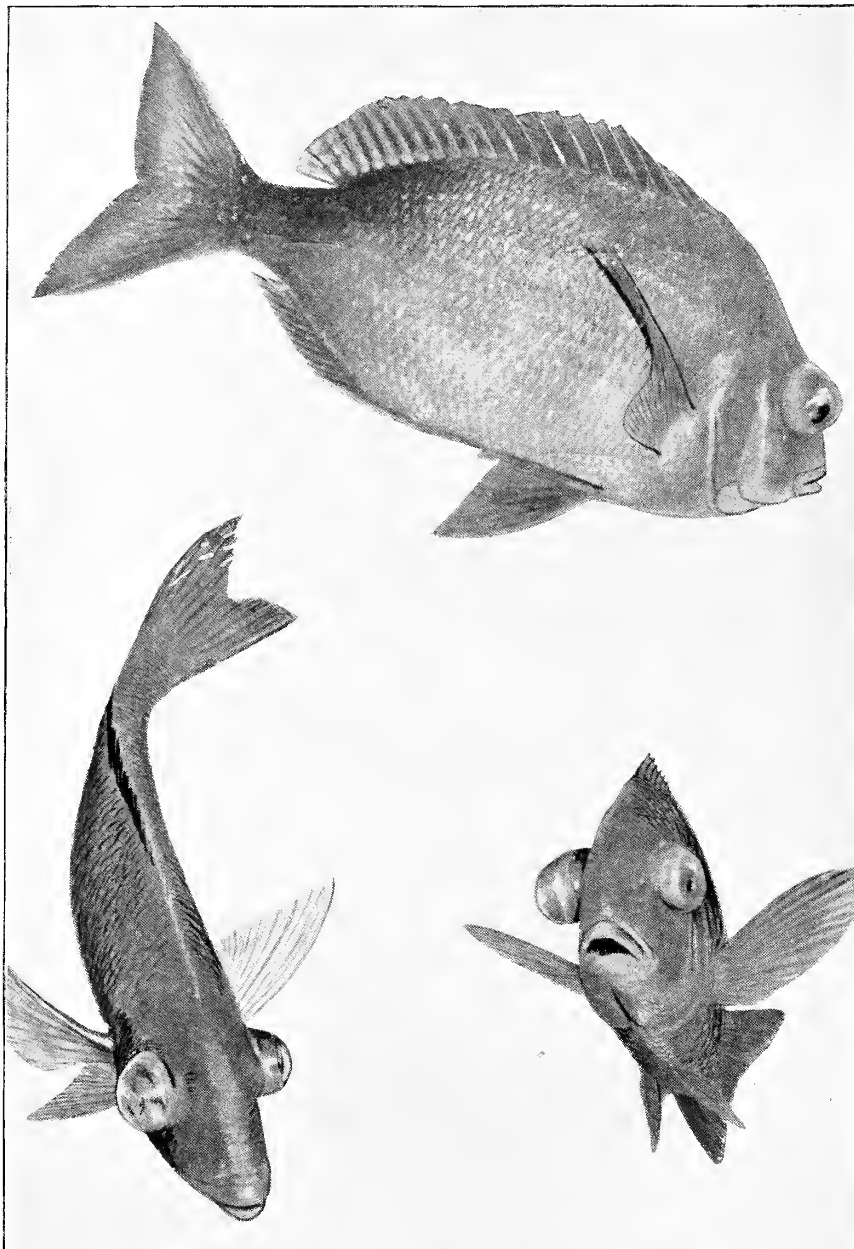

SCUP (*Stenotomus chrysops*). Three views of the same fish taken while alive in the aquarium of the United States Fish Commission at Woods Hole, Mass

Contributions from the Biological Laboratory of the U. S. Fish Commission,
Woods Hole, Massachusetts.

THE GAS-BUBBLE DISEASE OF FISH AND ITS CAUSE.

By F. P. GORHAM, A. M.,
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For several years it has been noticed that many salt-water fish when kept in aquaria develop, after a longer or shorter period, a disease which is first manifested in the formation of vesicles of gas on the fins or other parts of the body. These vesicles gradually increase in size and number, and finally invade all superficial parts of the animal. The fins, one after another, become affected, and the vesicles frequently form in the eyeball, beneath the cornea, or in the loose connective tissue of the orbit, so that the eyes are forced from their sockets; less frequently the bubbles gather beneath the mucous membrane lining the mouth and gill-arches, or beneath the integument, particularly along the lateral line, so that the scales are raised from the surface. The presence of these vesicles often disturbs the equilibrium of the fish so that it swims about with its head elevated, or, more frequently, directed downward or tilted to one side.

The disease has been noticed only in fish kept in the aquaria. It has not been found in specimens taken from the sea, nor has it been observed in fish kept in "cars" in deep water, nor in those retained in "pounds," the water of which is from 6 to 12 feet in depth. The affected fish live a shorter or longer time after the vesicles begin to appear, some succumbing in a few hours, others resisting the disease for several weeks. Young "puffers" usually die in less than 24 hours after being placed in the aquaria, but several scup lived for weeks after their eyes had actually dropped from their sockets.

The following fish were affected by the disease during the spring and summer of 1898, and the list includes all the fish, with two exceptions, which were kept in the aquaria of the Fish Commission at Woods Hole, Mass., from March to September:

Common name.	Scientific name.	Bathymetric range.
		Fathoms.
Winter flounder	Pseudopleuronectes americanus	1 to 30
Summer flounder	Paralichthys dentatus	1 30
Hog-choker	Achirus fasciatus	1 30
Tautog	Tautoga onitis	1 30
Tomcod	Microgadus tomcod	1 15
Squirrel hake	Urophycis tenuis	1 300
Hake	Urophycis chuss	1 150
Sea-robin	Prionotus carolinus	5 80
Sea-robin	Prionotus strigatus	5 80
Puffer	Spheroides maculatus	2 10
Toad-fish	Opsanus tau	1 8
Stickleback	Gasterosteus bispinosus	1 5
Cunner	Tautogolabrus adspersus	1 35
Pipe-fish	Siphostoma fuscum	1 100
Sea bass	Centropristes striatus	1 40
Butter-fish	Rhombus triacanthus	3 10
Rudder-fish	Palinurichthys perciformis	1
Scup	Stenotomus chrysops	2 20

The following invertebrates showed signs of the disease: Squid, naked mollusks, scallops (*Pecten tenuicostata*), hydroids (*Parypha crocea*). Squid egg-sacs and some of the green algæ also developed internal bubbles apparently of the same nature.

Minnows (*Fundulus heteroclitus* and *Cyprinodon variegatus*) and skates (*Raja erinacea*) in no case were affected.

In most fish the disease manifests itself first on the fins, but in the scup it attacks the socket of the eye and gradually forces the eyeball from the orbit (plate 12). In the adult puffer the dorsal fin is first attacked; in the young puffer the base of the tail. In the pipe-fish the bubbles appear about the snout and later spread to other parts of the body. In young winter flounders (about 1 centimeter long) the body cavity frequently contains a large bubble.

The disease is not confined to the aquaria at Woods Hole. Mr. L. B. Spencer, who is in charge of the Battery Park Aquarium in New York City, writes me that he has noticed it there for several years.

From the appearance of the fish, from the rapid development of the disease in fish introduced into the aquaria, and from the nonappearance of the disease in fish outside of the aquaria, it at first seemed to me that the aquaria had become infected with some disease-producing organism, that the organism was a "gas producer," and that it spread rapidly through the tissues of the fish and produced the gas which collected as bubbles in various parts of the body. With this idea in mind the task of finding, isolating, and studying the organism was begun.

All of the tissues of the fish were searched thoroughly for foreign organisms; hundreds of cultures were made on the ordinary and also on special media, such as fish-bouillon, fish-gelatin, and fish-agar. The cultures were kept warm, cold, and at the temperature of the water in the aquaria; cover-glass "smears" were repeatedly examined; but all to no purpose. Not a sign of any pathogenic organism was found. The only pathological change noticed in the tissues was a remarkably emphysematous condition of epidermis, muscles, connective tissue, fat, etc., in the neighborhood of the vesicles. I became convinced that the disease could not be attributed to the invasion of micro-organisms.

Two phenomena suggested a new line of inquiry: (1) None of the small shallow-water fish developed bubbles; (2) the deep-sea fish when brought to the surface by line or dredge often show a protrusion of the eyes and an expansion of the tissues, comparable to the conditions under consideration. Could not the disease be the direct result of the reduction of pressure upon the tissues of the fish, a reduction which must occur when animals habituated to a life in deeper water are compelled to live in the shallow water of the aquaria?

To answer this question the following experiment was made: Several young scup were placed in water in a flask; the air was then exhausted from above the water, thus reducing the pressure. As soon as the pressure was at all diminished, the fish immediately sought the bottom of the flask, heads down, and made every effort to seek deeper water and thus regain their normal pressure. By their continued struggles they soon became exhausted and came to the surface. The atmospheric pressure was then restored and they became quiet and swam about naturally. The reduction of pressure was repeated three or four times at intervals of 30 minutes. After the experiment the eyes of the fish showed well-developed bubbles. The experiment was repeated on the following day, with the same fish, with the result that the bubbles enlarged until the eyes began to protrude.

Other experiments, indicated in the following table, were made:

Fish.	Total length of time subjected to reduction of atmospheric pressure.		Results.
	Hrs.	*Mins.*	
Scup (5 cm. long)	1	0	Bubbles in eyes.
Same fish	1	0	Bubbles enlarged; eyes protrude.
Scup (5 cm. long)	1	12	One eye shows bubbles and hemorrhage.
Sea-robin (6 cm. long)	3	49	Bubbles on pectoral fin and on "feelers."
Sea-robin (6 cm. long)	0	14	Bubbles on lower jaw.
Puffer	4	4	Bubbles on tail.
Minnow (*Cyprinodon variegatus*)	6	0	No change.

Normal fish were kept as controls in all cases and showed no change. Whenever scup were subjected to this reduction their eyes were affected first; bubbles formed and the eyes protruded in much less time, but in exactly the same way as in scup placed in the aquaria. In the young sea-robins bubbles appeared on the pectoral fins and on the finger-like appendages, while in the young puffers they appeared at the base of the tail. In all these cases the parts first affected were the same as those subject to the disease in the aquaria. The minnows unaffected in the aquaria were unaffected by the removal of the atmospheric pressure.

Now, the question naturally arises, will the increase in pressure improve the condition of the fish already suffering from the disease? Small scup taken from the aquarium, already showing protrusion of the eyes and bubbles on the head and fins, were subjected to a pressure equal to 16 feet of water. In 24 hours many of the bubbles had disappeared, and the eyes had returned to their normal condition. Under this treatment puffers recovered from a decidedly diseased condition in 24 hours. The data of these experiments may be tabulated as follows:

Fish.	Length of time subjected to pressure of 16 feet of water.	Results.
	Hours.	
Scup with bubbles on head	24	Bubbles disappeared.
Scup with protruded eye	24	Eye nearly normal.
Scup with bubbles on head and protruded eye	24	Entirely normal.
Puffers (3.5 cm. long). Bubbles at base of tail	24	Do.
Puffer (3.5 cm. long). Bubbles on dorsal fin	24	Normal.
Puffer (3.5 cm. long). Bubbles on eye and on fin	24	Eye nearly normal. Bubbles on fin disappeared.
Puffer (3.5 cm. long). Large bubble under right fin.	24	Normal.

Control animals checked the results of these experiments.

In both the reduced and the increased pressure experiments above tabulated young fish were used, but whenever adult animals were employed similar results were obtained.

The change in pressure which fish must undergo when transferred from the ocean to aquaria is not small in amount. We have only to consider that at the surface the pressure is about 14.7 pounds per square inch, and that for every foot in depth it increases at the rate of 0.445 pound per square inch. At a depth of $5\frac{1}{2}$ fathoms the pressure is just double that at the surface, and at a depth of 300 fathoms it would amount to over 800 pounds.

Now, as may be seen by referring to the table of the depths from which the fish under consideration were taken, a reduction of pressure must take place when fish are confined in shallow aquaria. Their tissues relax under the reduction, and any gas present must expand. Since, according to the law of the expansion of gases, a volume of gas occupies just twice the space at the surface that it does at 5½ fathoms, a fish drawn from 300 fathoms to the surface must suffer an expansion of its contained gases to over 54 times their original volume.

Gas is present in all fish, in the alimentary tract, in the air bladder, and in the blood and other fluids of the body. As this gas expands and seeks an outlet the tissues are loosened and torn apart; the intestine and air bladder are greatly distended and perhaps ruptured, the circulation of the blood is impeded or stopped, and vesicles of gas form in various parts of the body.

These phenomena have been noticed for a long time in fish taken from great depths. Such fish are usually dead when they reach the surface, their eyes are protruded, their air bladder is ruptured, their intestines are everted from mouth or anus, and their scales are often lifted from the skin. The greater the depth from which they come the more pronounced are the changes. So great is the pressure to which some of the deep-sea fish are subjected (*Melamphaes beanii* from 2,949 fathoms sustains a pressure of 3.9 tons per square inch), that the structure of the bones, connective tissues, and muscles is peculiarly modified. Even in fish taken from 15 or 20 fathoms one may note the protrusion of the eyes, the eversion of the intestine, and the noise of the expanding gas working through the tissues.

We are thus led to the conclusion that the "gas bubble disease" is caused by a reduction of pressure. Naturally, the disease has never been noticed except in the aquaria; normally shallow-water fish are never affected, and the greater the normal depth of a fish the more severely is it affected. Occasionally certain deep-water fish voluntarily seek the surface, but it is only when they can not return to deeper water that the changes brought about by the expansion of gases become evident.

It is interesting to compare these changes in fish with those observed in higher animals when subjected to alterations of pressure. Animals at the surface of the earth are subjected to an atmospheric pressure of about 14.7 pounds per square inch. When this pressure is diminished or increased, physiological changes result. Mountain climbers, at an elevation of 2 miles, suffer from increased rapidity of respiration, quickened pulse, painful, throbbing headache, flow of blood from the nose, eyes, and mouth, nausea, and vomiting. On the other hand, when the pressure is increased to from 50 to 60 pounds per square inch, as in caissons, workmen experience an annoying sensation about the tympanum, an irritation of the skin called the "puces," an alteration of the voice, deep, slow, and easy respiration, active digestion, an absence of thirst, and an increased secretion of saliva and urine. Return to normal pressure has the same effect as going into rarefied air. The "puces" is replaced by a chill, respiration becomes difficult, the pulse is rapid and hard, there are pains in the joints and muscles, and persistent cramps, paralysis, and coma are frequent; death may result in a few minutes. In such cases autopsies have shown congestion of the viscera, emphysematous spots on the lungs, and other indications that the blood contained bubbles of gas.*

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*I am indebted to Mr. Frederick T. Lewis for calling my attention to these facts. See "The physiological effects of compressed air," in the Boston Medical and Surgical Journal, October 6, 1898.

Experiments have shown that under compressed air the amount of oxygen absorbed by the blood increases with the pressure, according to the law of the absorption of gases. It may be the liberation of this oxygen and other gases under reduced pressure that causes death in the above cases.

In recording experiments upon the influence of high pressures upon various animals, Monsieur P. Regnard says: *

A fish without an air bladder, or one in which the air bladder has been emptied of gas, can be submitted to a pressure of 100 atmospheres, 1,470 pounds per square inch, without injury. When the air bladder is not emptied a very curious phenomenon is observed. Under pressure of several atmospheres the gas of the air bladder dissolves in the blood, and at the moment of decompression it suddenly becomes disengaged in the blood vessels, forming a foam which stops all circulation, and the animal dies; for the same reason fish drawn from the depths of the sea are dead when they reach the surface.

The bearing of this matter of pressure on geographical distribution should be considered. It might seem that there are no barriers to universal distribution in the sea save those indicated by the isotherms, but the isobars must indicate the location of effectual barriers for certain species.

Since even slight changes of pressure are detrimental, and each fish swimming in the sea tends to remain at about one level, it is reasonable to suppose that when a fish leaves this level the difference of pressure becomes uncomfortable and there is a tendency for it to return to its normal habitat. The air bladder is at present considered not an organ under the influence of the muscles of the fish, by means of which it alters its specific gravity, but rather a delicate gauge, which notifies the animal of changes of pressure above or below the normal.

Were a fish to pass too far beyond its normal depth, either up or down, the expansion or contraction of the gas of the air bladder would so change the specific gravity of the animal that its muscular activity would no longer be able to cope with the upward or downward tendency, and the fish would be carried to the surface or the bottom. Thus the very presence of an air bladder works the destruction of the fish. Cases are reported where deep-sea fish have come to the surface in this way, evidently having been carried too far from their normal level in struggles with their prey.

It is true that slight changes of level may be brought about by the secretion or absorption of gas by the walls of the air bladder. That the walls of the air bladder secrete and absorb gas has been shown by experiment. I have repeatedly emptied the air bladders of fish and found a small amount of gas secreted in 24 hours. But this process of secretion and absorption is relatively slow, and permanent changes of habitat could be brought about only very gradually; moreover, only very slight changes are possible for each species.

Thus we see that fish are surrounded by barriers of pressure, and that each species and probably each individual is constrained to remain at a certain level, and the restricted distribution of certain fish is thus explained.

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* Recherches experimentales sur l'influence des très hautes pressions sur les organismes vivants. Compt. Ren., XCVIII, March 21, 1884, p. 745.

THE CLAM PROBLEM AND CLAM CULTURE.

By JAMES L. KELLOGG,
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At the present day the public seems to recognize quite fully the value of the work of our fish commissions—State and national. They know that through the artificial rearing of young shad from the egg the United States Fish Commission has saved our shad industry on the Atlantic coast from inevitable ruin. They have also seen the direct benefit, in thousands of instances, of the stocking of inland streams and lakes with fish which have been hatched and cared for until they were old and strong enough to care for themselves. There does not, however, seem to be so general an appreciation of the fact that the shellfish—the oysters, clams, and scallops—of our eastern coast also need to be very carefully conserved in the immediate future. For some years past there has been considerable study and discussion of the artificial methods of oyster propagation, and in some of the North Atlantic States, especially Rhode Island and Connecticut, "oyster farming" has been the means of saving the industry. But the oyster question is not yet solved, and much remains to be done in the development of new methods of artificial propagation, if the supply is to meet the increased demands of the future. The appropriations for State and national commissions are much too small to allow extended investigations along these lines, though public money could probably not be expended with better results to the whole people than in this way.

Quite unexpectedly we are confronted with a new problem. Over the greater part of the New England coast the supply of clams has suddenly diminished to an extent which has become alarming. Extensive areas which four or five years ago produced great numbers of clams are now practically barren. The explanation is simply that the demand has increased at such a rate that too large a number of the natural "seed" clams have been removed, and extinction suddenly follows. The beds should recover themselves quickly, but one man, in wandering day after day over an area of many acres thus impoverished, is easily able, by digging up the few large clams which he may find here and there, to absolutely prevent the possibility of establishing a new supply. Not only are the larger clams now sought for, but in some localities those which will measure little more than *one inch* in length are dug up and sent to market. The demand is increasing and prices are rising.* When a certain locality is exhausted, the amount taken from others still productive is conse-

* Large clams sell in the Fulton market for 6 cents apiece.

quently much greater. We may thus understand why the calamity—for such it really is—has suddenly fallen.

In certain localities, of course, this exhaustion of the clam beds took place many years ago, and it is interesting to notice that, for the reasons given above, they have ever since remained practically barren. The history of one of these regions demands especial attention, being particularly instructive at present, because a considerable effort has been made there to reclaim the barren flats.

At the mouth of the Essex River, just north of Gloucester, Mass., are some very extensive flats, upon which immense numbers of clams were formerly found. Several years ago these flats were rendered practically unproductive through excessive digging, and have remained so until the present time. About ten years ago the only serious experiment at clam culture of which we have any record in this country was attempted here. It proved to be a failure, and yet the reasons for the failure are easily found, and the fact is demonstrated that the methods employed would have been entirely successful if the experimenters had been protected from outsiders and from each other.

In the report of the United States Commissioner of Fish and Fisheries for 1894 we find the following reference to the Essex experiment, quoted from Mr. Ansley Hall:

> I found quite an interesting feature in connection with the clam fisheries at Essex, Mass., in the shape of clam culture. In 1888 an act was passed by the legislature authorizing the selectmen of the town to stake off, in lots of 1 acre or less, each of the flats along the Essex River, and let them to persons desiring to plant clams, for a rental of $2 per acre or lot for five years and an additional fee of 50 cents. Thus far 37½ acres have been taken up and seeded with clams. Small clams are dug on the natural beds and planted on these hitherto unproductive flats. Mr. J. Bennett Fuller states that about 500 bushels are required to plant an acre properly. During the first two years (1889 and 1890) the people were slow to avail themselves of the privilege of planting for fear that after they had spent their time and labor they would not be able to secure protection from trespassers. But in 1891 and 1892 lots were obtained and planted. The principal difficulty encountered has been the loss of clams by the sand washing over them, the bottom in some localities being soft and shifting. In 1892 there were 25 acres that were quite productive, about one-third of the entire catch of the section being obtained from them. The catch from these lots is not definitely known, but is estimated at about 2,500 barrels.
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> The cultivated clams possess some advantage over the natural growth from the fact that they are more uniform in size and are as large as the best of the natural clams. They bring $1.75 per barrel, while the natural clams sell for $1.50 per barrel. This is the price received by the catchers. One acre of these clams is considered to be worth $1,000, if well seeded and favorably located so as not to be in danger of being submerged with sand. This valuation would be too high for an average, since all the acres are not equally well seeded and located. The clammers are generally impressed that the industry can be extensively and profitably developed, and their only fear is that they will not be able to secure lots permanently. The greater part of the land available for this purpose is covered by the deeds of people owning farms along the river, and the consent of the land-owners has to be obtained before lots can be taken up. It seems probable, however, that the business will continue to progress unless checked by complications that may arise relative to the occupancy of the grounds.

This report is in the main correct, but there are some points in which it seems to be in error. Perhaps its author in stating that the flats were previously unproductive did not mean that they had always been so. The testimony of the older inhabitants is that at one time most of the flats, and the river banks back to the town of Essex, were covered with clams.

Another statement is that many planted clams were lost by shifting sand. In one or two instances trouble of this kind occurred on some of the river clam banks, but it was very insignificant, considering the total area seeded. For the last two

years at least, so far as I am able to determine, there has been very little change in the contour of the flats. There has been some shifting of sand and extension of the thatch plants, but these changes have been relatively unimportant.

Very much less than the estimated 500 bushels were put upon an acre of ground, and the clammers generally believe that half of that amount would be sufficient. As a matter of fact, few of the areas leased were properly planted, and for this and other reasons all estimates of the amounts which should be obtained as a result of planting under the most favorable circumstances are of little value.

As stated in the report, the cultivated clam rapidly became large and uniform in size, and hence had a high market value.

We have much evidence that the clam industry in Essex has in the past been extensive. From a curious little volume, which was published in 1868 by a local clergyman, on the "History of the Town of Essex from 1634 to 1868," I find the following paragraph:

For the last twenty years * about 50 men and boys have been employed, chiefly in the spring and fall, in digging clams for fishing bait. For this purpose the clam flats in each town (Essex and Ipswich) are, by law, free to all its residents, and to no others. Five bushels of clams in the shell, it is usually reckoned, make one bushel of "meats"; about 2½ bushels of the latter are put into each barrel, and this quantity an able-bodied man can dig in three tides. One bushel of dry salt is used for each barrel. During this period of twenty years about 2,000 barrels of clams have been dug yearly, on the average, and sold at an average price of \$6 per barrel. Deducting the cost of the barrel, \$1, and of the salt, 75 cents, the sum of \$4.25 per barrel, or \$8,500 per year, has been earned in this business. The bait has been marketed chiefly in Gloucester.

Mr. J. B. Fuller, an old resident of Essex, has this to say of the former industry:

When I was a boy there were about 100 men who were making a business of digging clams in Essex, while to-day there are not 10 who get their whole living by it. In those days a man could make from \$2 to \$5 and some times \$7 or \$8 a day. Now they obtain from 50 cents to \$1.50 per day, with just as many acres capable of bearing clams as formerly and with a much better market. The demand, also, is rapidly growing. Then, again, the amount of labor now necessary is only about two-thirds of that formerly required, for then clams usually had to be taken out of the shell, and now they are shipped as they are taken from the bed.

Much more testimony of a similar character may be had to show that the flats, once very productive, have almost entirely failed, and in spite of the effort made to reclaim them.

It is not difficult to determine the reasons for the failure of the culture experiment at Essex. The areas upon which clams were planted were those which were at the time unproductive. The beds still containing clams—the "town flats"—were free to any native of Essex. The one thing which was absolutely necessary to the success of any planter was that the clams on his leased ground should not be disturbed by other diggers. This protection was apparently not given in any case by the town authorities, and, as no person lived within sight of the majority of the beds, it was quite impossible for any man to guard his property much of the time.

As to what followed it is not easy to obtain definite testimony from the clammers themselves. Other citizens of the town, however, and some few clammers, intimate that most of the men began to take clams from any property but their own, and that

* Presumably dating from 1868.

in this way the full result of no man's labor in planting was ever realized. Others who did not make clam-digging a regular business, but only dug occasionally, are said to have had no respect for the rights of those who had leased property. It was said that at times when vessel builders and the shoe factory released employees, many of them, for lack of other occupation, turned their attention to clam digging, with the result that too many clams were at the time taken from the flats.

Another reason for the failure of the Essex experiment is that a number of short-sighted clammers began to fear, after the clams had been planted, that the production might suddenly become so great as to glut their market and, as a consequence, force prices down. Some few individuals, inspired by this fear, are reported to have said and to have done everything in their power to prevent the success of the experiment. In all cases, it is said, the selectmen of the town, who issued the leases, refused their aid in the prosecution of trespassers.

In spite of the fact, which had been demonstrated in the experiment, that when properly planted the clams grew much more rapidly and became much larger than on the natural beds, no applications for a renewal of the leases were made when the first ones expired. No change in the condition at Essex may be hoped for until there is some evidence that a law protecting the planter will be strictly enforced. With proper protection a great industry might, and probably would, be quickly established, not only in Essex, but in any region where clam flats are now unproductive because of excessive digging.

It would be comparatively easy to formulate plans which, if carried out in this region, should reclaim the Essex flats. No single method would, however, be acceptable to all who are interested in the clam industry, and we have reason for believing that the few dissatisfied might easily defeat the efforts of the majority. The whole problem, as shown in the history of the oyster industry in this country also, narrows itself down to the simple question of protection. The leasing of lands to individuals is the necessary first step, and when the town or State authorities are willing to protect the lessee, the problem will be solved. This plan of leasing to individuals would seem to be the best one. Much may be said positively in its favor. A strong negative argument we have also, when we consider that any other scheme must depend for its success upon the cooperation of all concerned for the common good. We might know that this would hardly be possible, even if we had not the history of past events on these flats to guide us.

Mentioning a few of those plans which do not consider the lease, the first is a closed season. If all digging could be prohibited for one or two years, many clams would come to maturity, the young would establish themselves, and the beds would once more become productive. Undoubtedly this recovery would be rapid. But it must be remembered that in this process the clams would probably crowd each other closely, as they have done on the few natural beds existing to-day, and a season or two of thorough digging and thinning out would be necessary before many clams reached a large size. This thinning process would not be immediately advantageous, on account of the small size of the clams, and hence would probably not be done at all.

Another plan, proposed by some of the clammers, is that every man who makes a business of digging clams be required by law to deliver and plant on barren flats, set aside for the purpose, a certain number of small clams in the months of April or May—this planted area to be protected for a season, and eventually extended until

all the barren flats are covered, all flats upon which clams had matured to become common property. The fatal objection to this, as well as to the closed season, is that every man's interest is bound up in that of his neighbor, and he would be constantly haunted with the fear of not realizing his full share of the profits. This would prompt him to make sure of his own, and the result would be the quick and certain defeat of the whole plan. These communistic schemes have been tried often in our country in recent years, and we are able to know from their almost universal failure that this would certainly fail. Besides, the difficulty of determining who were really engaged in the clam business—making it a means of livelihood—would be very great. How much work, in planting for the public, should be asked of the man who digs clams for market only occasionally? It would also be difficult to determine when the public work had been done.

The lease, with swift and certain enforcement of a law against trespassers, would at once establish a great industry where there is now only the prospect of continued desolation.

The flats at Essex afford an opportunity for producing an immense number of clams. Great tracts, with here and there a growth of thatch plants, are exposed at low tide. Down near the opening to the sea the sands shift to some extent, but in almost every other locality the changes are so slow and so slight that clams are not affected by them. A glance at the appended map will give some idea of the immense size of this tract. But the map itself shows only what are known as the south flats. Stretching in a northwesterly direction from the region about Choate Island is an area of flats which many of the clammers claim to be larger than the one shown in the map. Unfortunately I was not able, when I visited Essex in August of 1898, to go over this ground as I did the south flats, but I could see from Choate Island that it was extensive.

In constructing my map I have represented the natural beds—areas where clams can now be found—by stippling. The beds which were planted in the culture experiment are again almost entirely barren. Of course clams may be found here and there on these tracts, but they are few in number. The clams of the natural beds are generally too small to market, chiefly because they are so closely packed together. If the majority of such clams were removed for planting elsewhere the natural beds themselves would soon produce an abundance of large clams.

The most important feature shown by the map is the extent of nonproductive ground, where every natural condition is favorable for the growth of clams. These areas were formerly, as I have indicated, natural beds. They are represented by the oblique shading lines. Almost every foot of ground for hundreds of yards about the point where the Essex River widens out into the great flats, might and should be yielding great quantities of the finest of clams, and this without glutting the markets near at hand, which are now forced to obtain their small supply from the Maine coast. These barren beds extend far up the river toward the town and into the mouths of the numerous creeks emptying into it, some of which are indicated in the diagram. I have been told by old clammers that at one time the mouths of these creeks were stocked with fine clams, and that in the late fall and early spring they afforded good shelter from the wind for men engaged in digging. The thatch banks, represented by short lines and stipples, contain at present great numbers of clams. The tough roots of the thatch vegetation, however, prevent digging, except along the edges and where the plants are scattered.

The map represents the extensive clam flats at the mouths of the Essex and Castle Neck rivers within the townships of Essex, Ipswich, and Gloucester. To the north and west of Choate Island, and connected with this, is an area of beds nearly as extensive as those represented in the map.* The main features illustrated are—

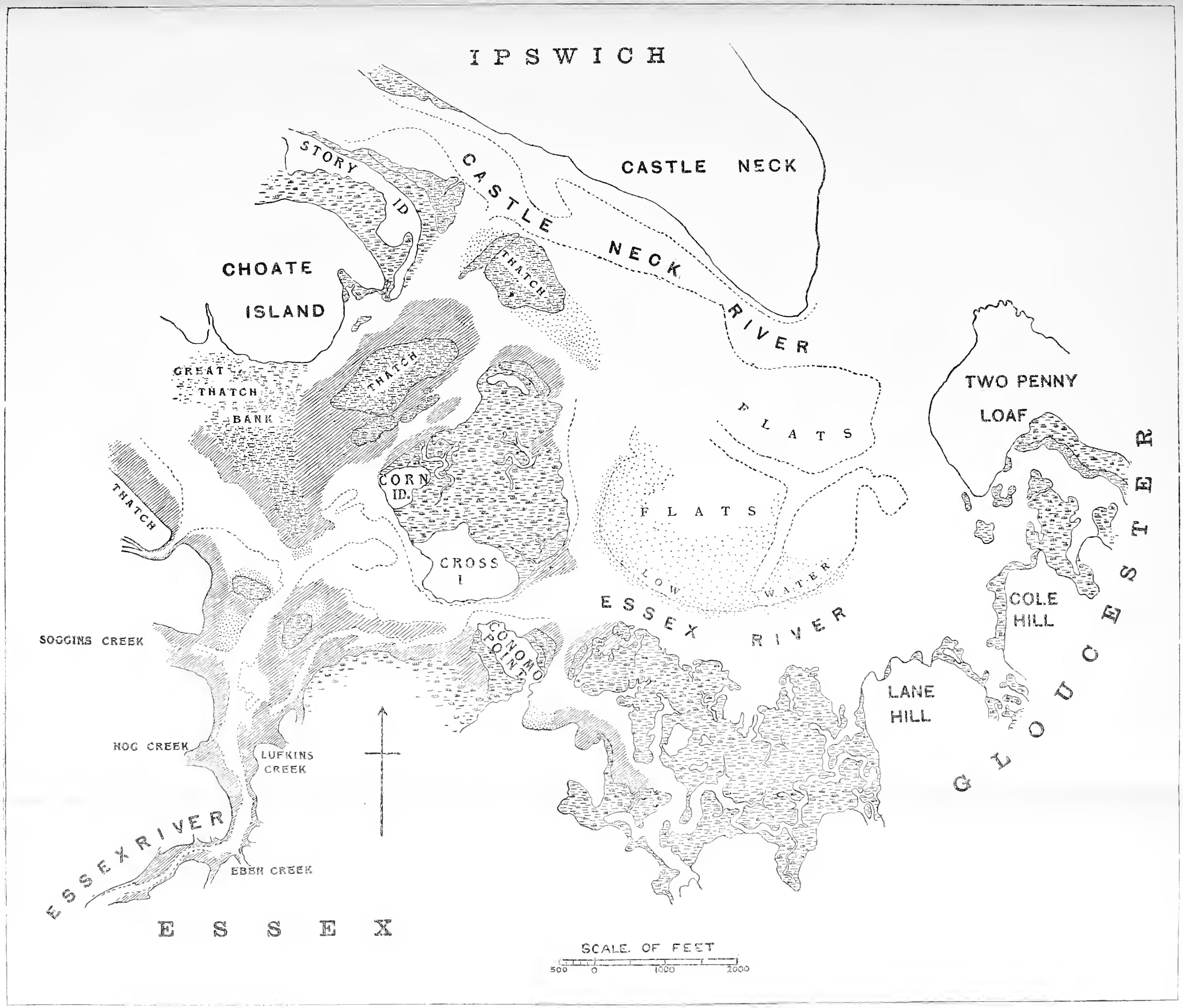
1. The present extent of the "natural beds" (this was determined in August of 1898). These are represented by stippling. Though the beds appear to be extensive, the clams are in some places much scattered, and in others so densely packed as not to be able to grow. Very few marketable clams are taken from these beds.

2. The great areas—represented by oblique shading lines—where every natural condition is favorable for the growth of clams. These beds are and have been for years practically barren. At one time producing an immense harvest, they were reduced and have since been kept down by excessive digging. The flats planted in the culture experiment are those directly west of Conomo Point and along the river banks.

3. The thatch banks, submerged at high tide, which, on account of their tough roots, hold great numbers of clams safe from molestation. They probably produce great numbers of young, which under favorable conditions should replenish the losses, from judicious digging, of the entire area.

4. The extent of the flats as a whole, indicating how great an industry might be supported in this region.

* While many kindly gave their assistance, I am especially indebted to Mr. J. B. Fuller and to Mr. E. Hobbs, of Essex, for their aid in collecting the data used in text and map.



MAP SHOWING CLAM FLATS AT MOUTHS OF ESSEX AND CASTLE NECK RIVERS, MASSACHUSETTS.

DESCRIPTIONS OF NEW SPECIES OF FISHES FROM THE HAWAIIAN ISLANDS BELONGING TO THE FAMILIES OF LABRIDÆ AND SCARIDÆ.

By OLIVER P. JENKINS,

Professor of Physiology, Leland Stanford Junior University.

The fishes here described are part of three collections from the Hawaiian Islands. The largest collection, containing over 200 species, was made by me in 1889 under the generous auspices of De Pauw University. The second, of about 45 species, was obtained, under the direction of Dr. David Starr Jordan, by the United States Fish Commission steamer *Albatross* in 1896, on the return of the vessel from the work of the Fur Seal Commission of Investigation. The third contained some 80 species, and was made by Dr. Thomas Denison Wood, of Stanford University, in 1898, for the museum of the university. To this a small but valuable collection was added by his brother, Mr. A. B. Wood, of Honolulu, in 1899. A fuller account of these collections will appear in a subsequent paper. Of the 22 new species here described, 17 were first obtained by me in 1889 and 5 were first seen in Dr. Wood's collection.

With but one exception the fishes collected by me were examined in a fresh state and careful notes of the color were taken. Of the 5 from the collection made by Dr. Wood, all were seen after they had been in formalin for some weeks. While the markings were fairly well preserved, and in some cases brilliant coloration still remained, still the quickness with which the colors of these groups fade or change makes definite statements of color of these 5 species impossible.

In all 42 species of labroids and scaroids were obtained. The large percentage of these that appear to be new would indicate that these islands and their neighbors lying west and south form a most interesting field for the study of these forms. While this fauna has already received the attention of Bleeker, Günther (on Garrett's collections and drawings), Steindachner, and other ichthyologists, our knowledge of it is only in its beginning.

The fishes of these groups were mainly obtained from the market in Honolulu, which is supplied by the native fishermen. The species are all valued highly by the native Hawaiians as food, the scaroids especially so. Some small specimens of the latter bring large prices. They are eaten raw by the natives, as are most of the other fishes, cooking being regarded as especially inimical to the food qualities of a scaroid. The Honolulu fish-market is the richest source of the collector's material. Fishermen, who know the habits and haunts of these fishes, and who have great skill in catching them, are urged to bring them here by the high price and ready sale of these forms.

The types of these species are deposited in the museum of Leland Stanford Junior University. Series more or less complete are also placed in the De Pauw University museum, the United States Fish Commission, and the United States National Museum.

LIST OF SPECIES.

Macropharyngodon aquilolo Jenkins, new species. Native name, *Hinalea akilolo,* applied also to other fishes. Fig. 1.

Head with flap 3.33 in length of body to base of caudal; 4 in total; depth 2.5; in total 3. D. IX, 11. A. III, 11. Scales 2–28–10. Tubes two to three branched, or single. Head naked. Four front teeth in each jaw, strong, the second on each side of upper jaw turned backward, prominent posterior canines at each angle, two at one angle in one specimen.

General color in life a light-brown, sometimes darker; a very bright-blue spot on each scale, this spot with a black posterior border; five bright-blue lines on side of head running obliquely downward and forward; two parallel ones from eye to mouth, the third from just below lower border of eye to chin below angle of mouth, the remaining two lower; bright-blue spots and short lines on top of head and on opercle. The positions of these lines are constant in the five specimens examined. Dorsal and anal with three longitudinal series of bright-blue spots with black borders, the inner and middle series being large and distinct spots; anterior dorsal spot between first and third spines bright-scarlet, bordered below with bright-yellow, and below this with dark-green; pectoral plain-brown; ventrals bright-brown with about six transverse series of bright-blue ocelli; caudal with about five transverse series of bright-blue ocelli. The coloration is quite constant in the five specimens taken, varying only in darker or lighter shade of brown of the general color.

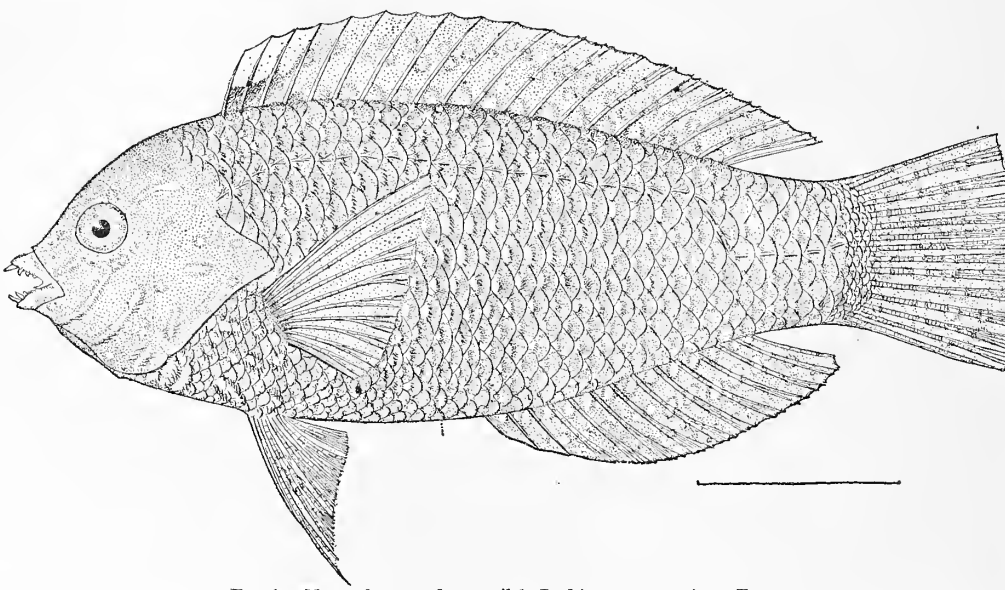


FIG. 1.—*Macropharyngodon aquilolo* Jenkins, new species. Type.

Allied to *M. geoffroyii* Bleeker, Proc. Zool. Soc. 1861, and Atl. Ichth, p. 129, tab. 37, fig. 5, from which it differs in form of body and pectoral and ventral fins, and in coloration of body, head, and fins. The peculiar form of the pharyngeal teeth seems to be a sufficient character upon which to found Bleeker's genus *Macropharyngodon,* which is here retained. Type No. 6130, L. S. Jr. University Museum.

This very beautiful fish is not common at Honolulu; some fishermen had never seen specimens before. The five obtained by me were taken with the hook. Their measurements were as follows:

Macropharyngodon aquilolo.	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	Macropharyngodon aquilolo.	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
	mm.	*mm.*	*mm.*	*mm.*	*mm.*		*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
Length to base of caudal	99	103	112	90	105	Height of first dorsal spine	10	8	10	9	10
Caudal	17	23	23	22	25	Height of soft dorsal	15	19	18	15	16
Total length	116	126	135	112	130	Soft anal	15	19	18	15	16
Head	30	34	34	30	34	Ventral	25	27	29	24	26
Depth	40	44	46	40	41	Pectoral	25	27	29	24	26
Eye	7	7	7	6	7	Width of body	11	11	15	11	11
Snout	9	11	11	10	11						

Halichœres iridescens Jenkins, new species. Native name, *Ohua paawela.* Fig. 2.

Head with flap in length of body to base of caudal 3.5, in total length 4; depth 3.16, 3.66. D. IX, 12. A. III, 12 (in one specimen III, 11). Scales 3-27-8. Outline elliptical, body compressed, somewhat elevated; teeth 2-2, posterior canine in each jaw. Type No. 6131, L. S. Jr. University Museum.

Coloration in life: Each scale with a dark-red crescent spot, convex anteriorly, this spot bordered posteriorly with blue; head bright-red, with bright-green stripe on median line from snout to base of caudal, a bright-green stripe along upper margin of eye on to body, where it continues more or less distinctly just above lateral line about half the length of body; a narrow green line from snout to middle of anterior margin of eye, a bright-green stripe from near angle of mouth along lower margin of eye to opercular flap, where it is confluent with a wide bright-green band from the chin backward over lower limb of preopercle and the subopercle and opercle; this green gradually shading into blue on throat and belly; a black spot behind eye surrounded by bright-green, with red spots in some specimens; dorsal fin dark-red, with a row of dark-green oblong spots on proximal border, one spot on each interspinous membrane, a green longitudinal band on outer portion, with a very narrow outer margin of light-blue; a black spot in membrane between first and second spines; in one specimen a double blotch between first and third soft rays, a median row of green spots. The detail of markings in this fin varies in the three specimens. Anal dark-red with a green band along central portion, outer margin with narrow blue line; caudal dark-red with a crossband of bluish-green at the base, with two or three other crossbands often broken up into spots of green with orange centers; ventrals blue, with dark line on anterior portion; pectorals pale-red, with base and axils bright-green.

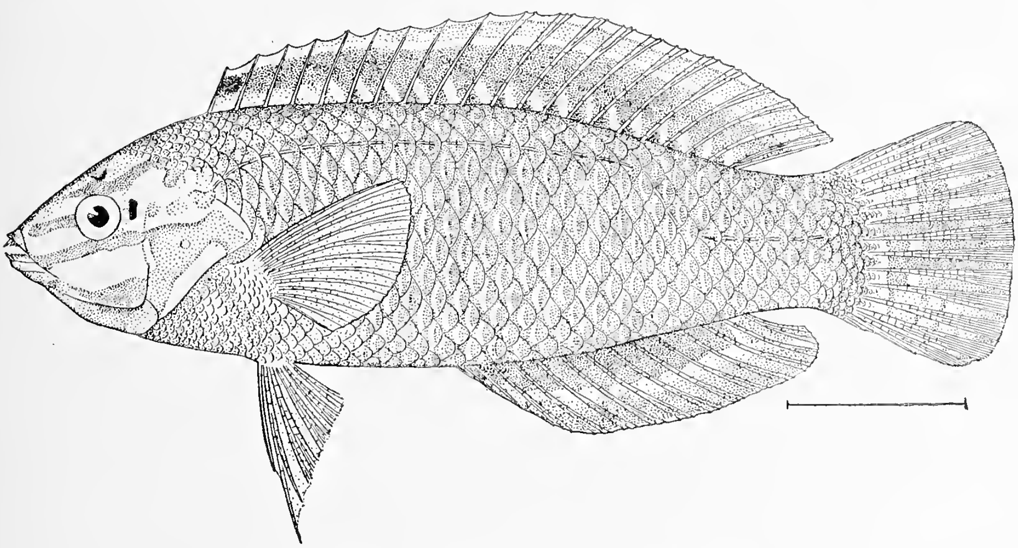


FIG. 2.—*Halichœres iridescens* Jenkins, new species. Type.

Coloration similar to that of *Julis ornatissimus* Garrett. Garrett's description is incomplete, but shows that this fish differs in marked points of coloration, notably in conspicuous black spot behind eye, spot on anterior portion of dorsal, form of markings on the scales, and in number of anal rays.

A very brilliant fish, taken from the coral reefs, apparently not very common. Three specimens were taken by me, measuring 140 mm., 130 mm., and 120 mm. Detailed measurements of the last are given below:

Halichœres iridescens.	Millimeters.	Halichœres iridescens.	Millimeters.
Body to base of caudal	120	Longest soft ray of dorsal	18
Caudal	20	Longest soft ray of anal	17
Total length	140	Pectoral	22
Head with flap	34	Ventral	30
Head without flap	30	Eye	6
Depth of body	38	Snout	12

Halichœres lao Jenkins, new species. Native name, *Lao*. Fig. 3.

Head with flap 3.4 in body to base of caudal; in total 4. Depth 3.4. D. IX, 12. A. III, 12 (the first anal spine showing only on dissection). Scales 2–29–9. Lateral line continuous, tubes branched. Posterior canines present, two prominent canines in front portion of each jaw. Body compressed, not elevated; fins moderate; caudal rounded; anal reaching vent; soft dorsal and soft anal equal in height and are one-half length of head with flap.

Coloration, body pink, lower parts blue; dark-brown spot on each scale; a green line on middle line of head from snout to origin of dorsal; a bright-green line from snout backward just above eye to body, where it is continued as a row of indistinct spots just above lateral line nearly to caudal; another green line from mouth just under eye to opercular flap; another broad green band covering lower limb of preopercle and suboperele, and lower portion of opercle joining the last on posterior portion of opercle; space between last two green bands a bright pink; coloration of head similar to that of *H. iridescens;* a black spot behind eye; dorsal fin with three black ocellated spots; the first, small and least distinct, is between first and second dorsal spines; the second, larger than eye, from first to third soft rays; the third, smaller, from tenth to eleventh soft rays; base of pectoral green; base of caudal orange and green.

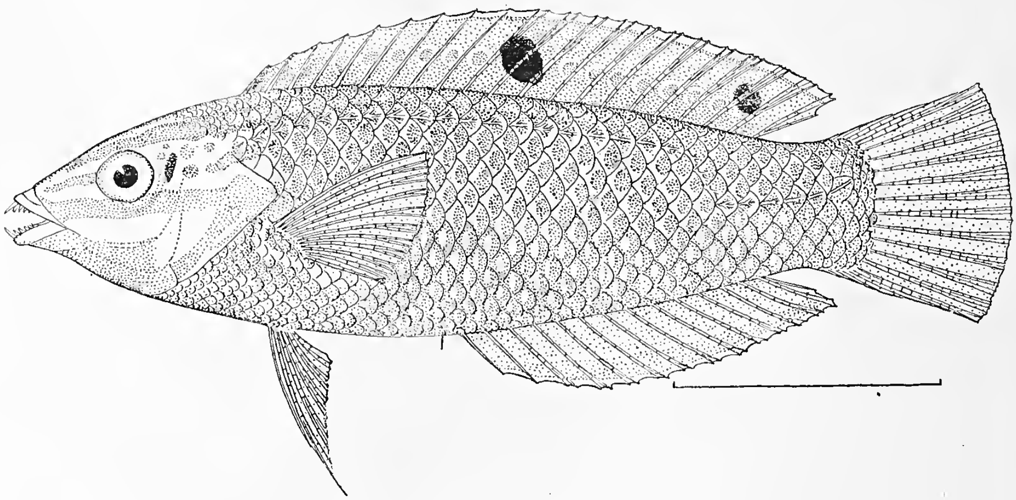


FIG. 3.—*Halichœres lao* Jenkins, new species. Type.

Allied to *H. iridescens,* from which it differs in the more slender and less elevated body, somewhat longer head, and in coloration. The most conspicuous point of difference is the presence of black ocellated spots on dorsal.

Type No. 6132, L. S. Jr. University Museum.

One specimen was taken by me, the measurements of which were as follows:

Halichœres lao.	Millimeters.	Halichœres lao.	Millimeters.
Body to base of caudal	82	Longest soft ray of dorsal	12
Caudal	13	Longest soft ray of anal	12
Total length	95	Pectoral	16
Head with flap	24	Ventral	18
Head without flap	22	Eye	6
Depth of body	24	Snout	8

Coris lepomis Jenkins, new species. Native name, *Hilu lauli*. Fig. 4.

Head, with flap, in length to base of caudal 3.16; in total 3.66; depth 3.66. D. IX, 12. A. III, 12. Scales 7–85–33. Lateral line continuous. Teeth, two strong canines in front of each jaw, followed by smaller teeth in single series; a posterior canine. Head naked; body elliptical, scales on breast and before dorsal smaller; two anterior dorsal spines slightly produced and flexible, remaining spines pungent; caudal fin slightly rounded; ventrals not produced, not reaching vent.

Coloration in life: General color bright-blue, sides rosy, a series of about five or six short (about one-fourth depth) oblique indistinct dusky bars on sides of body just behind pectoral fin, behind this an indistinct rosy patch; head, throat, breast, and belly covered with bright-golden spots and short irregular bars of same color. All the fins bright-blue with golden reticulations, which are especially bright on vertical fins; opercular flap large, terminating with a black spot as large as eye, posterior border of this spot with a narrow yellow border, anterior golden border. This spot is very similar to that seen on a sunfish (*Lepomis*).

One fine specimen of this beautiful fish was obtained by me. Type No. 12141, L. S. Jr. University Museum. It gave the following measurements:

Coris lepomis.	Millimeters.	Coris lepomis.	Millimeters.
Head with flap	123	Height of soft anal	45
Flap	23	Ventral	65
Length to base of caudal	388	Pectoral	72
Total length	450	Eye	15
Depth	127	Snout	40
Height of soft dorsal	45		

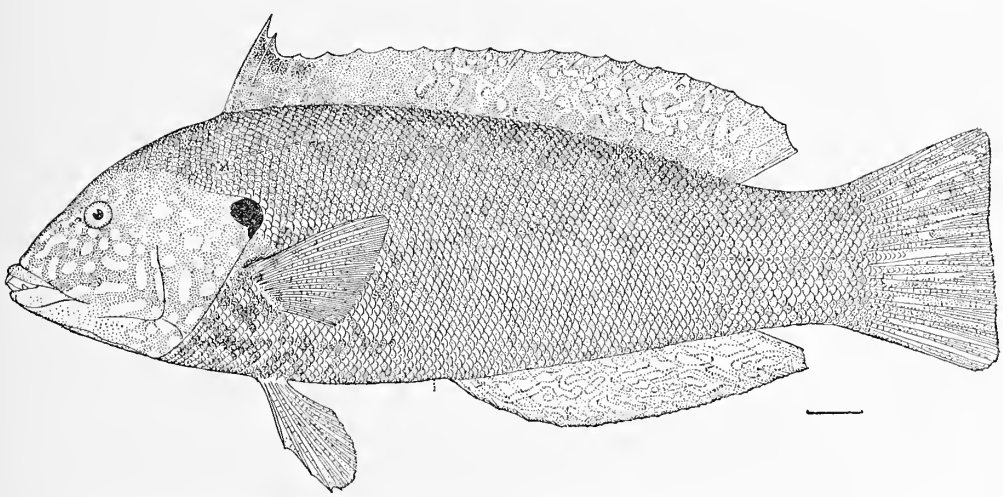


FIG. 4.—*Coris lepomis* Jenkins, new species. Type. Figure not quite accurate in proportional measurements.

Hemicoris remedius Jenkins, new species. Fig. 5.

Head with flap 3.66 in body to base of caudal; in total length 4.33; head without flap 4.40 and 5.25. Depth 2.66 and 4.5. D. IX, 12. A. III, 12. Caudal rounded; first rays of ventral produced, reaching second anal spine. Scales 3-54-17; tubes simple; scales with tubes 50; scales on throat small, those on belly not much smaller than on body; head naked; rows of small scales extending on membranes between the caudal rays. Teeth, four prominent canines in upper jaw, two in lower, the second pair not much larger than those of series following; posterior canine tooth present.

Coloration in life: Body brown, dark above, light below; a bright-red band from eye along lateral line to its downward bend; a bright-red band from opercular flap extending backward to tip of pectoral, from which it is broken up into a series of short oblique crossbars on every alternate row of scales, becoming less distinct toward caudal peduncle; a bright-red band curving downward just below anterior portion of middle line of body, becoming indistinct about below a vertical from twelfth dorsal spine; another bright-red band from axil curving downward and extending backward to about second soft ray of anal; a bright-red band from angle of mouth curving upward to lower margin of eye, and down to edge of opercle just below flap; a bright-red band from a short distance behind symphysis curving upward over cheek and downward across middle of posterior margin of opercle on to breast to a point just behind base of ventrals; a bright-red band on each side of middle

line of throat; a short red bar at symphysis; a red spot just above and back of eye; anterior portion of opercular flap scarlet, bordered posteriorly first with black, then with bright yellow; spinous dorsal with a longitudinal band of red on middle portion, which on soft portion is broken up into small wavy lines and reticulations. In one young individual there is a black spot at root of sixth dorsal ray, one at root of the third from last, and one at roots of last two. These spots do not appear in the four large specimens. Caudal with crossbars of red alternating with yellow, somewhat wavy; pectorals plain yellow, base red; ventrals golden-yellow. A very bright fish.

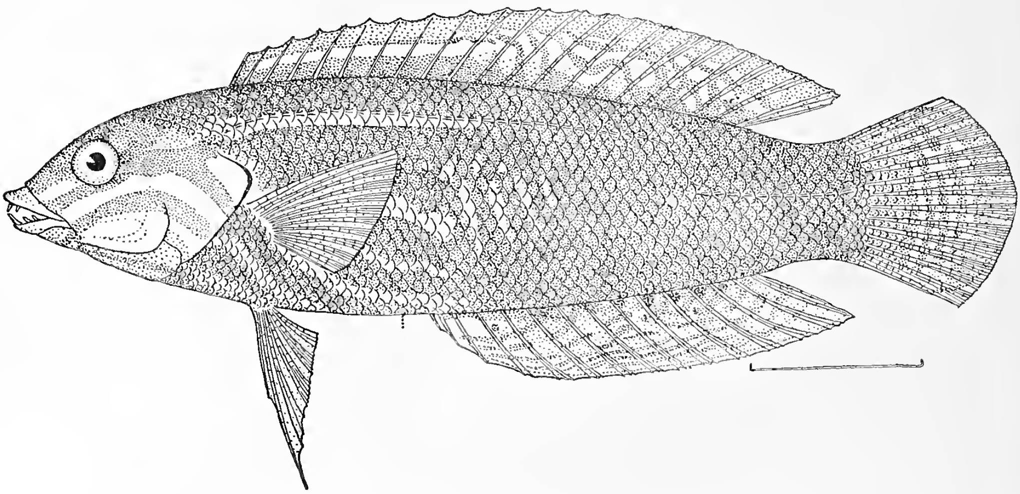


FIG. 5.—*Hemicoris remedius* Jenkins, new species. Type.

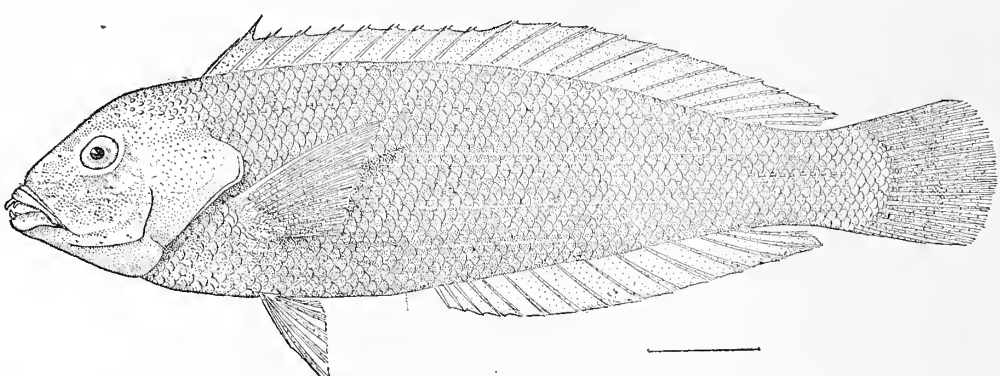


FIG. 6.—*Hemicoris keleipionis* Jenkins, new species. Type. Figure not quite accurate in proportional measurements.

Formerly valued by the natives as a medicine, the purpose not clearly stated. This species seems to be well known by the natives.

Type No. 6133, L. S. Jr. Univ. Mus. Five specimens, taken by me, had total length, including caudal fin, 15. cm., 15.5 cm., 14.3 cm., 15 cm., 12 cm.. respectively. Measurements of one are given below.

Hemicoris remedius.	Millimeters.	Hemicoris remedius.	Millimeters.
Body to base of caudal	133	Longest soft ray of dorsal	19
Caudal fin	24	Longest soft ray of anal	19
Total length	157	Pectoral fin	25
Head with flap	36	Ventral fin	32
Head without flap	30	Eye	7
Depth of body	37	Snout	9

Hemicoris keleipionis Jenkins, new species. Fig. 6.

Head 3.2 in body to base of caudal, 3.8 in total length; depth 3.6 to base of caudal, 4.5 in total length. D. IX, 12. A. III, 12. Scales 56, with tubes 50. Head entirely naked, bases of vertical fins not sheathed. Teeth pointed, two rows in each side of upper jaw, a single series in lower; no posterior canine, the two anterior canines strong and curved outward. First dorsal spine somewhat extended, spinous portion lower than soft rays; the caudal rounded; anal less high than dorsal; ventral not quite reaching vent.

Coloration in alcohol (not seen fresh): General color of body pale with tinge of pink, with about 21 distinct narrow longitudinal stripes, these running through upper border of each row of scales and lower border of the adjacent row; head pale without markings; ventral fins white; dorsal showing trace of a longitudinal line about one-third its height from outer margin; anal with no markings except faint trace on portions of outer margin; caudal showing remains of about five irregular cross-bands; pectoral and ventrals colorless and without markings.

This species is dedicated to Mr. Keleipio, of Honolulu, who rendered very valuable aid in securing the fishes of Dr. Wood's collection.

One specimen was obtained by Dr. Wood at Honolulu. Type No. 6049, L. S. Jr. University Museum. The following are its measurements:

Hemicoris keleipionis.	Millimeters.	Hemicoris keleipionis.	Millimeters
Total length	224	Soft dorsal	25
Length to base of caudal	190	Soft anal	20
Caudal	34	Pectoral	38
Head	59	Ventral	30
Depth	50	Snout	22
First dorsal spine	22		

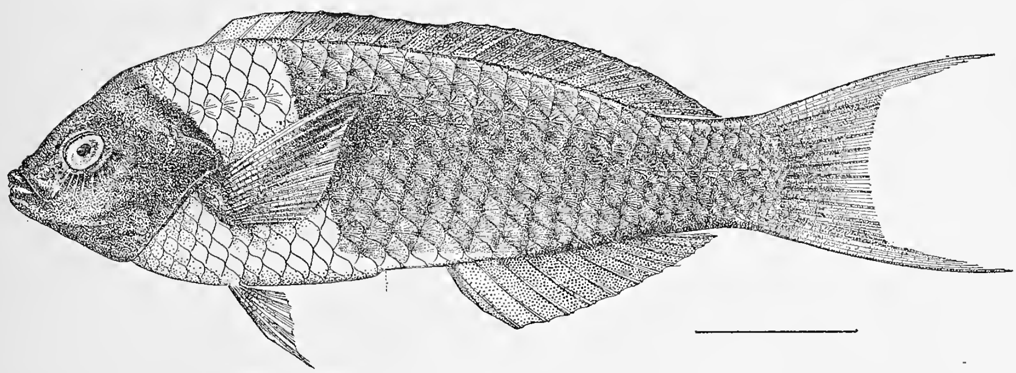


FIG. 7.—*Thalassoma pyrrhovinctum* Jenkins, new species. Type.

Thalassoma pyrrhovinctum Jenkins, new species. Native name, *Hinalea lauli*. Fig. 7.

Head with flap in body to base of caudal 3.4, in total, 4; depth in body to base of caudal 3.25, 3.6. D. VIII, 13. A. II, 11. Scales 2–28–9. Lateral line continuous, tubes three-branched. Teeth, two prominent canines from which the remaining ones of the series are graduated in size, no posterior canine. Caudal lobes produced, ventrals somewhat prolonged.

Coloration in life: Colors very bright; the whole head dark purple without markings, this color extending a very short distance on body; behind this coloration, a broad orange area extending around body from head as far back as third dorsal spine; remainder of body, with dorsal, anal, and caudal fins dark purple, with (in some specimens) reddish coloration; upper lobes of caudal sometimes distinctly reddish-brown; upper lobes of caudal much produced, amount varying, in some equaling three-fourths length of head; pectoral with a broad dusky bar extending from middle of fin to tip; axil and base of fin a dark purple; ventrals produced. Mrs. Whitney, of Honolulu, has shown me a series of colored drawings of Hawaiian fishes made by her, in which the colors represented are as contained in my notes with the exception of representing color of body behind the orange bar as dark green, each scale with a vertical brown line; dorsal and anal fins very dark purple.

This fish is similar to *T. melanoptera* (Günther), differing in conspicuous orange band from head to third dorsal spine extending around body, in dark-purple color of caudal, and in ventrals being pro-

duced. The fish identified by Streets, Bull. U. S. N. M., No. 7, 1877, as ?*Julis melanoptera*, is probably this species In his specimen the colors were faded, which may account for absence of orange area.

This fish is common. Many specimens were obtained by me and three by Dr. Wood, the largest being 165 mm. in length. Type No. 6138, L. S. Jr. Univ. Museum. The measurements of one are given:

Thalassoma pyrrhovinctum.	Millimeters.	Thalassoma pyrrhovinctum.	Millimeters.
Body to base of caudal	137	Height of longest soft dorsal	15
Caudal (middle)	22	Height of longest soft anal	14
Total length	159	Pectoral	31
Head with flap	40	Ventral	23
Head without flap	35	Snout	8
Depth of body	44	Eye	7

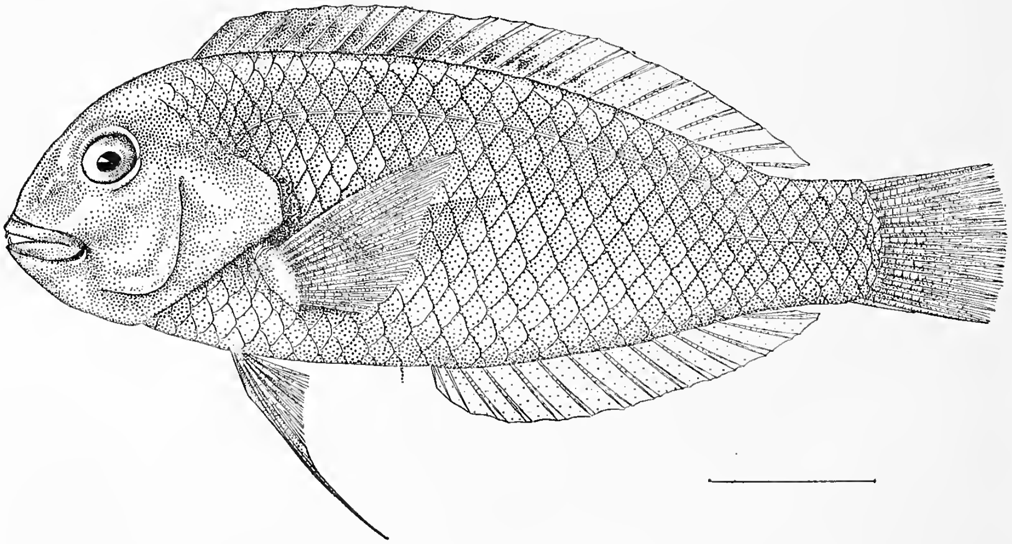


FIG. 8.—*Novaculichthys woodi* Jenkins, new species. Type.

Novaculichthys woodi Jenkins, new species. Fig. 8.

Head 3 in body to base of caudal (3.5 in total); depth 2.6 in body to base of caudal (3.1 in total); D. IX, 12. A. III, 12. Scales 27 (24 with tubes single). Body deep, compressed; profile of head obtuse, evenly curved; eye but small distance above axis of body; distance from margin of eye to angle at mouth 3½ in head. Scales 2-27-9; head naked; the area in front of ventrals naked, or with few deeply imbedded scales; scales on sides of breast somewhat smaller than on sides of body. Teeth conical, in a single series, two anterior canines in each jaw, the lower two fitting in between upper two; no posterior canine. Anterior spine flexible, next less so, the remaining pungent; origin of dorsal in advance of base of pectoral; height of the soft dorsal nearly 3 in head; ventral spine short, strong, pungent; first soft ray filamentous, reaching somewhat beyond origin of anal; caudal rounded; pectoral 1½ in head.

Coloration: In alcohol, general color body pale without markings; fins white, except membrane of spinous dorsal, which is black; black dots on membrane between first 3 or 4 soft rays.

Similar to *Novaculichthys entargyreus* Jenkins. This species is named for Dr. Thomas Denison Wood, professor of hygiene in Stanford University, who obtained two specimens at Honolulu.

Type No. 6029, L. S. Jr. Univ. Mus. The measurements of two specimens are given:

Novaculichthys woodi.	No. 1.	No. 2.	Novaculichthys woodi.	No. 1.	No. 2.
	mm.	*mm.*		*mm.*	*mm.*
Body to base of caudal	130	131	Longest soft ray of dorsal	16	15
Caudal	25	27	Pectoral	29	30
Total length	155	158	Ventral	37	37
Head with flap	44	44	Eye	9	9
Depth of body	49	50	Snout (from margin of eye)	10	11
Longest spine of dorsal	12	13			

Novaculichthys entargyreus Jenkins, new species. Fig. 9.

Head 3.2 in body to base of caudal (4 in total); depth 2.7 to base of caudal (3.2 in total). D. IX, 12. A. III, 12. Scales 27 (24 with tubes, tubes single). Body deep, compressed; profile of head obtuse, evenly curved; eye only moderately high; distance from margin of eye to angle of mouth about 4 in head. Scales 2–27–9; head naked; area in front of ventrals naked or with few deeply imbedded scales; scales on sides of breast somewhat smaller than on sides of body. Teeth conical, in a single series, two anterior canines in each jaw, the lower two fitting in between upper two; no posterior canine. Dorsal fin continuous, the anterior spines not protruding, the spinous portion lower than soft portion; anterior spine flexible, the next less so, remaining ones pungent; origin of dorsal in advance of base of pectoral; soft dorsal 2.5 in head; ventral with a short, pungent spine; first soft ray filamentous, just reaching vent; caudal rounded; pectoral 1.5 in head.

Coloration (in alcohol): Body and fins pale, without distinct markings; two broad longitudinal silvery bands along sides of body, the pigment being in the skin below the scales but showing through; transverse narrow silvery markings on peritoneum show through between ventrals and vent.

One specimen of this fish, 140 mm. in length, is in the collection made by Dr. Wood, at Honolulu. Type No. 5984, Leland Stanford Jr. University Museum. Its measurements follow:

Novaculichthys entargyreus.	Millimeters.	Novaculichthys entargyreus.	Millimeters.
Body to base of caudal	117	Longest soft ray of dorsal	14
Caudal	23	Longest soft ray of anal	13
Total length	140	Pectoral	25
Head (with flap)	37	Ventral	28
Depth of body	44	Eye	8
Longest spine of dorsal	9	Snout (from margin of eye)	8

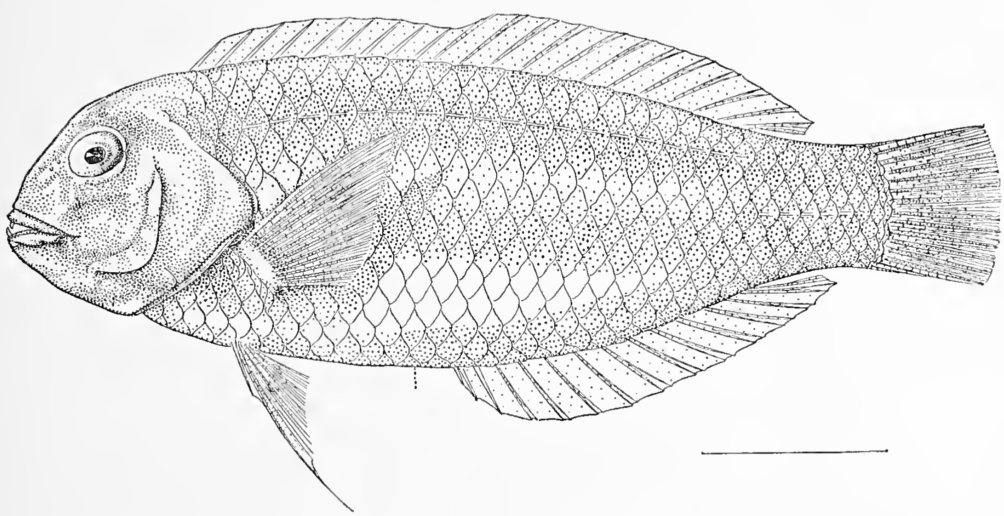


FIG. 9.—*Novaculichthys entargyreus* Jenkins, new species. Type.

Hemipteronotus umbrilatus Jenkins, new species. Native name, *Lae nihi*. Fig. 10.

Head, with flap, in length to base of caudal 3.5, in total 4; depth 2.8, 3.2. D. II–VII, 12. A. III, 12. Scales 2-25-9, tubes simple, lateral line interrupted; scales behind eye, cheeks covered with small scales, opercles and preopercles scaleless; the two anterior spines of the dorsal not produced, separated from remainder of dorsal by narrow space not quite twice eye. Teeth, two prominent canines in anterior part of each jaw, the lower fitting between the upper.

Coloration in life; general color a light-drab, with posterior portion of each scale white or whitish; a large dark-brown blotch, large as head, on middle portion of body, in which blotch the posterior half of each scale is white; the anterior separated portion of dorsal dusky; no distinct markings on the fins.

Type No. 6135, L. S. Jr. University Museum.

One specimen obtained by me, of which the following table of measurements was taken:

Hemipteronotus umbrilatus.	Millimeters.	Hemipteronotus umbrilatus.	Millimeters.
Body to base of caudal	107	Longest soft ray of anal	13
Caudal	16	Pectoral	22
Total length	123	Ventral	20
Head with flap	31	Eye	7
Head without flap	27	Snout	15
Depth of body	38	Anterior portion of dorsal	12
Longest soft ray of dorsal	13		

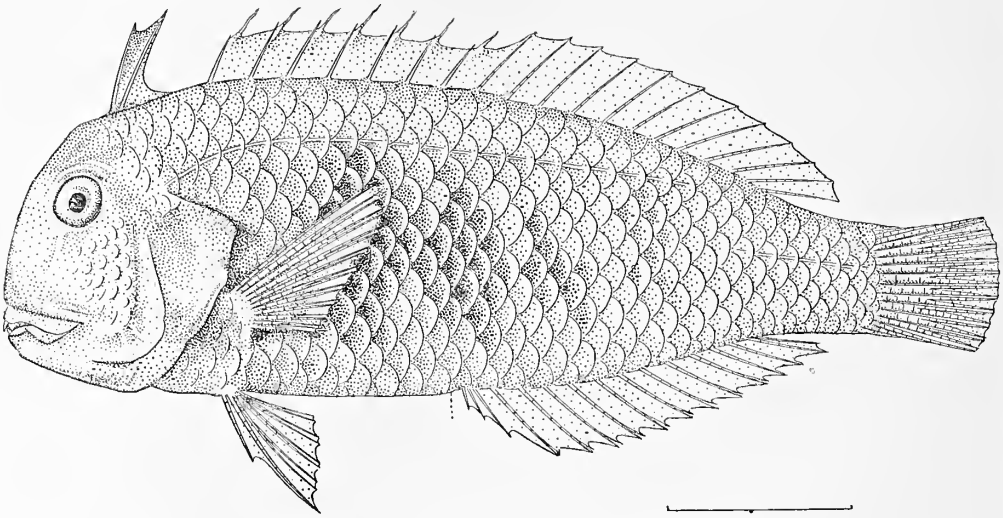


FIG. 10.—*Hemipteronotus umbrilatus* Jenkins, new species. Type.

Iniistius leucozonus Jenkins, n. sp. Native name, *Lae nihi*, applied to other fishes, also. Fig. 11.

Head in body to base of caudal 3.2, in total 3.7; depth 3.5. D. II–VII, 12. A. III, 12. Scales 2–26–9; lateral line interrupted, tubes simple. Two prominent canines in anterior part of each jaw, the pair in lower jaw fitting between those in upper and projecting above the jaw; no posterior canine; gill-rakers minute; upper edge of head sharp; the two anterior rays of dorsal produced, and separated from remainder of dorsal by a space equal to snout; a very few scales just behind eye; rest of head, cheeks, opercles, and preopercles scaleless.

One specimen was obtained by me, from which were taken the following measurements:

Iniistius leucozonus.	Millimeters.	Iniistius leucozonus.	Millimeters.
Body to base of caudal	112	Height of soft anal	18
Caudal	18	Height of anterior dorsal	36
Total length	130	Pectoral	22
Head with flap	35	Ventral	24
Head without flap	29	Eye	7
Depth of body	37	Snout	14
Height of soft dorsal	15	Depth of head	31

Coloration in life: Body with four white bands alternating with four bands of brown to olivaceous; first brown band covering posterior portion of opercle and body just posterior below, being in width from base of ventral nearly to anal; second brown band in width from seventh spine to fifth soft ray of dorsal, extending on anal; third, from ninth to last soft dorsal ray, extending on anal; fourth brown band on base of caudal; a brown dart from eye to angle of opercle; middle line of snout, chin, and throat yellow; two dark brown lines from eye to eye over head; small black spots above and behind eye; several scales in upper part of second brown band on body with distinct brown dots; a scale in second row just below fourth spine jet black; anterior dorsal with alternating dark and white spots; second portion of dorsal with three ocellated black spots; first between second and third spines, the longest as long as snout; second between first and fourth soft rays; third between eighth and tenth soft rays, lying on ninth; pectorals colorless; ventrals olivaceous.

Allied to *Inistius tetrazonus* Bleeker, which it resembles, but from which it differs in having three ocelli on dorsal, and a distinct black spot on scale below third or fourth dorsal spine also. Type No. 6137, L. S. Jr. University Museum.

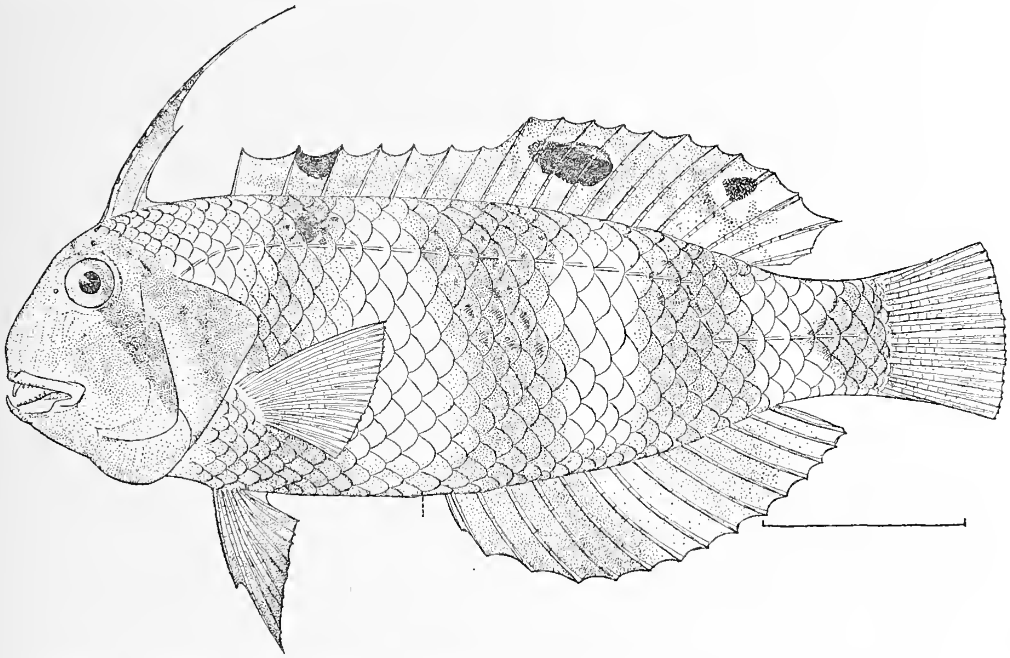


FIG. 11.—*Iniistius leucozonus* Jenkins, new species. Type. The first anal ray in figure should be a spine.

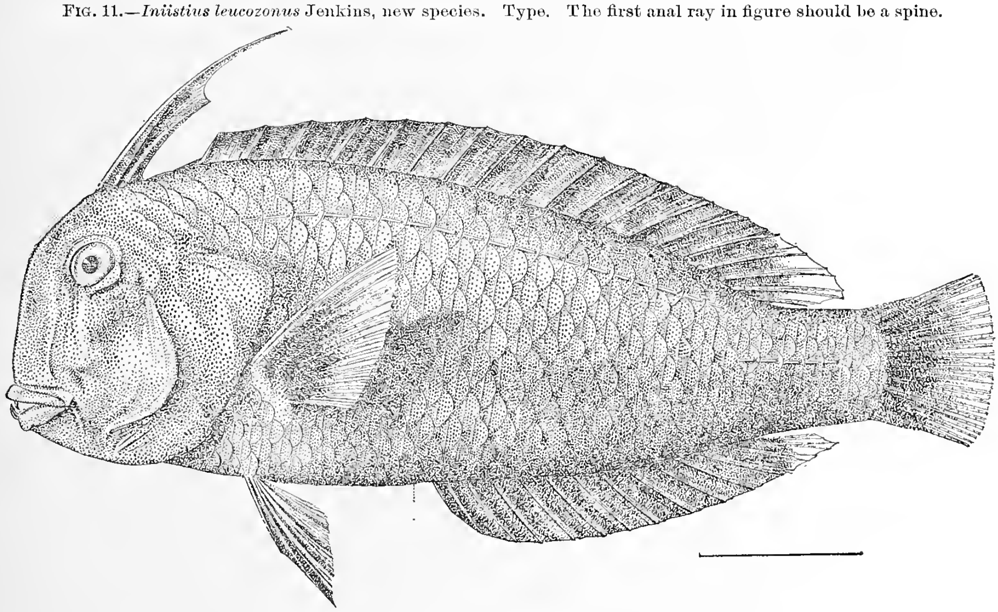


FIG. 12.—*Iniistius verater* Jenkins, new species. Type.

Iniistius verater Jenkins, new species. Fig. 12.

Head 3 to base of caudal, 3.5 in total; depth 2.75, 3.1 in total. D. II–VII, 12. A. III, 12. Eye 6 in head; snout 2.2 in head; body deep, compressed; profile of head vertical; eye high near upper margin of head; posterior angle of mouth in a vertical line below front margin of eye, distance of eye from this nearly half the length of head. Scales 2–28–11; head naked except deeply imbedded

scales on nape and faint trace of margins of two or three scales deeply imbedded just behind eye; scales on breast smaller than on sides of body; each scale with a delicate vertical ridge running across its center; tubes in lateral line single. Teeth conical, in a single series, the two anterior in each jaw enlarged canines, the two lower fitting between those of upper; the core of each tooth black, showing through. Two anterior dorsal spines stand over eye free from rest of dorsal, the space between them and remaining dorsal equaling half length of second spine, these two spines prolonged, the first filamentous, its height nearly equaling head; ventrals just reaching vent, caudal rounded.

Coloration in alcohol: The whole body and fins black except tips of posterior two or three rays of dorsal and anal fins, posterior half of caudal, and most of the pectoral fins, which are white, being black-blotched at the base.

This description is based on two specimens collected in the Honolulu market by Dr. T. D. Wood in 1898. Type No. 5990, L. S. Jr. University Museum. The measurements of the two are given below:

Iniistius verater.	No. 1.	No. 2.	Iniistius verater.	No. 1.	No. 2.
	mm.	*mm.*		*mm.*	*mm.*
Body to base of the caudal	135	120	Longest soft ray of dorsal	17	17
Caudal	27	24	Longest soft ray of anal	19	19
Total length	162	144	Pectoral	28	25
Head with flap	46	42	Ventral	26	23
Head without flap	39	31	Eye	8	7
Depth of body	52	44	Snout (from margin of eye)	22	19
Longest ray of anterior dorsal	41	39			

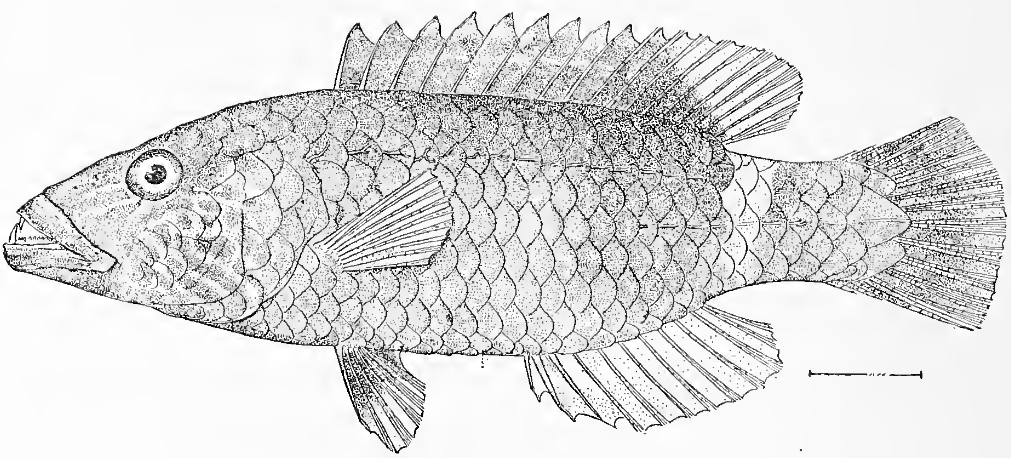


FIG. 13.—*Cheilinus zonurus* Jenkins, new species. Type.

Cheilinus zonurus Jenkins, new species. Native name *Poou*. Fig. 13.

Head, with flap, to base of caudal 2.9, in total 3.4; depth 3 (3.8 in total length). D. IX, 10. A. III, 8. Scales 2–21–6; lateral line interrupted, 23 or 24 in upper portion; 14 or 15 scales with tubes, some simple, some branched. Two strong canines in anterior portion of each jaw, no posterior canines; lower jaw produced, its canines fitting in between those of the upper; gillrakers, on lower limb 10, short, conical; on upper about 6, mostly rudimentary. Body somewhat compressed, elliptical, contracted suddenly at caudal peduncle; lower jaw produced; head concave above eye; caudal rounded; soft dorsal like soft anal, posterior portion of each the higher; two rows of scales on cheek, preopercle naked, opercle with two, subopercle one row of scales.

General color a dull red to drab, each scale with a vertical line of brighter red; a series of orange lines running obliquely downward and backward on each side of face to edge of operele, and from eye forward to mouth; a light-red band around caudal peduncle just behind dorsal and anal fins; spinous dorsal mottled with dark, with two longitudinal orange stripes more distinct anteriorly; posterior portion of soft dorsal light pink; anal fin rosy, brighter anteriorly; caudal with many dull shadings, with olive prevailing toward outward margin; pectoral pale-red, with yellow base; ventral rays rosy, membranes white, a large dusky-red spot on anterior portion, showing only on upper surface.

This fish appears to be the same as that identified by Smith & Swain as *Cheilinus diagramma* Lacépède, Proc. U. S. Nat. Museum 1882, 133, in a collection of fishes from Johnson Island, Pacific Ocean. Type No. 6134, L. S. Jr. University Museum. The measurements follow:

Cheilinus zonurus.	Millimeters.	Cheilinus zonurus.	Millimeters.
Body to base of caudal	188	Longest soft ray of anal	26
Caudal	38	Pectoral	33
Total length	226	Ventral	29
Head with flap	66	Eye	19
Depth of body	60	Snout	27
Longest soft ray of dorsal	26		

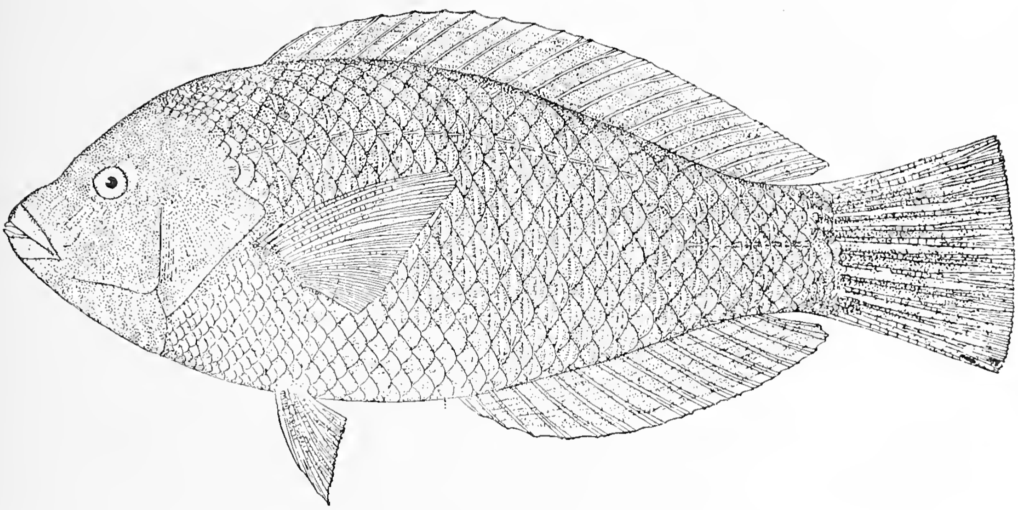


FIG. 14.—*Anampses evermanni* Jenkins, new species. Type.

Anampses evermanni Jenkins, new species. Fig. 14.

Head, with flap, in body to base of caudal 3 (in total 3.6); depth 2.2 (2.5). D. IX, 12. A. III, 12. Scales 4–26–11; scales with tubes 28, tubes mainly simple. Lateral line continuous. Two prominent canine teeth in each jaw, flattened with cutting edge. Body oval, deeper in front; scales large, those in front of dorsal and on breast small; a row of small scales at base of anal and at base of anterior part of dorsal; caudal truncate; ventrals not much produced, reaching origin of anal. Opercles with prominent striations radiating from upper anterior angle; striations also on subopercle, preopercle, and interopercle; dorsal spines flexible at tips. Coloration, brownish-red, with a vertical blue line on each scale; snout blue; chin, throat, and sides of face with blue reticulations; dorsal fin color of body, outer margin blue, fin covered with 7 or 8 longitudinal wavy blue lines and rows of dots, some running into each other and making reticulations; anal, ground color red, outer margin blue, fin with 4 or 5 distinct blue longitudinal lines; ventral, anterior margin blue, fin red with blue lines and dots; pectoral olive, anterior margin blue; caudal red, with longitudinal blue line. The coloration of the first is almost exactly the same as in *Anampses cuvieri.*

Allied to *Anampses godeffroyi* Günther, differing in coloration and number of scales. Four specimens taken by me; total length of each, respectively, 297, 260, 295, 295 mm. Type No. 6136, L. S. Jr. University Museum. The measurements are given below:

Anampses evermanni.	Millimeters.	Anampses evermanni.	Millimeters.
Length of body to base of caudal	250	Soft dorsal	35
Caudal	47	Soft anal	32
Total	297	Eye	11
Head with flap	82	Snout	30
Head without flap	74	Ventral	42
Depth	112	Pectoral	62

Calotomus irradians Jenkins, new species. Fig. 15.

Head 3.33 (in total 3.9); depth 2.33 (2.9). D. IX, 10. A. III, 9. Scales 25. Teeth pointed, both tips and margins free, posterior surface adnate to dental plate, of about equal size in both jaws; at least one strong tooth at posterior angle of each upper jaw, curved backward and downward; teeth in oblique series of about 5 series in each half of upper, and of about 8 series in each half of lower jaw; 3 to 4 teeth in each series. Scales on cheek in a single series, 6 in number, 4 scales in median line before dorsal, 3 scales before ventral, this line continued by 2 scales between bases of ventrals, forming a sort of appendage in this position; scales not reduced on breast; one and one-half series of scales between lateral line and base of dorsal, the half series only slightly sheathing base of dorsal fin. Dorsal spines flexible; origin of dorsal, base of pectoral, and base of ventral fins in a vertical line; posterior margin of caudal a straight line, except moderate prolongation of upper rays, longest ray 2.4 in head; ventrals reaching halfway to vent; pectoral fin broad as long, longest rays (second and third) 1.5 in head. Posterior margin of fin slightly convex.

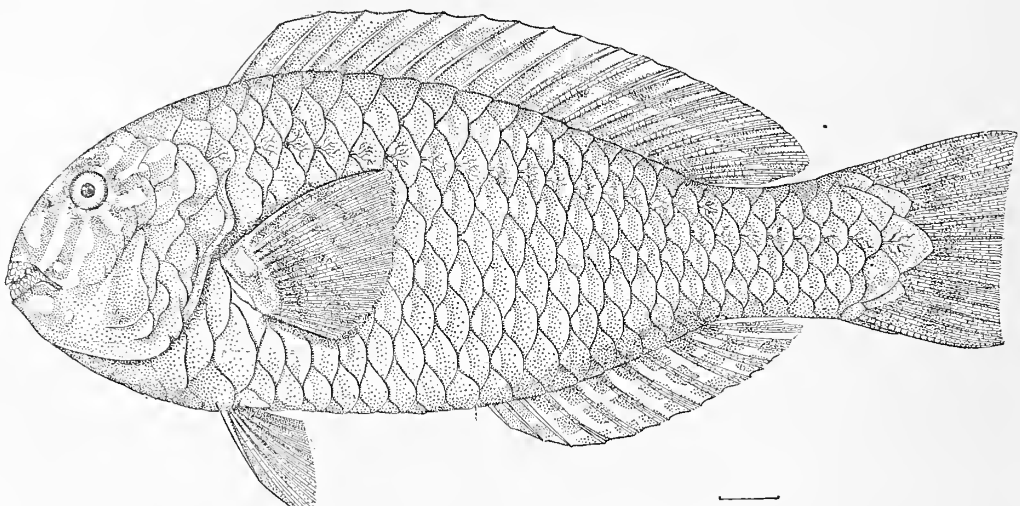


FIG. 15.—*Calotomus irradians* Jenkins, new species. Type.

Color in life: General color of body and fins blue; head, chin, and throat bright-blue, marked with pink, arranged as follows: About 8 bands radiating from eye and a number of bands and irregular figures on snout, face, and occiput, and a few small spots on chin; of the pink bands radiating from eye 2 reach region of angle of mouth, 2 join the irregular markings on face and occiput, and 4 radiate over the region of cheek and behind eye; a vertical bar of pink on each scale; in some regions this bar is partly concealed by overlapping scale; vertical fins bright-blue, with reticulations and spots of pink; ventrals blue; pectorals blue, olive, and pink.

This very beautiful fish is somewhat rare and is very highly prized by native fishermen for virtues they suppose it to possess. They usually ask an exorbitant price for it. The description is based on two specimens, one obtained by me in 1889 and one by the *Albatross* in 1896. Type No. 12142, L. S. Jr. University Museum. The measurements of the two are given below:

Calotomus irradians.	No. 306.	No. 1298.	Calotomus irradians.	No. 306.	No. 1298.
	mm.	*mm.*		*mm.*	*mm.*
Length total (to end of middle of caudal)	415	410	Depth	150	150
Length to base of caudal	350	345	Height of longest soft dorsal	45	45
Caudal (middle)	65	55	Height of longest soft anal	47	45
Caudal, longest upper limb	79	75	Pectoral	73	73
Head with flap	108	106	Ventral	60	60
Head without flap	96	94	Snout	47	46
			Eye	16	16

Scarus brunneus Jenkins, new species. Fig. 16.

D. IX, 10. A. II, 9. P. 13. V. 6. Head 3 in length to base of caudal; in total (to middle of caudal) 3.5. Depth 2.6 in length to base of caudal; in total (to middle of caudal) 3.1. Scales 24; lateral line interrupted, scales slightly roughened by striations of minute tubercles; tubes, some single, some once or twice branched. Body deep, compressed. Teeth whitish, a tooth at posterior angle of upper jaw on one side in one specimen, the largest, none in 7 others. Upper lip double the whole length, broad, nearly covering dental plate; lower lip covering more than half of lower dental plate. Cheek with two rows of scales, 6 in upper and 5 in lower row; no scales on anterior limb of preopercle; a row of scales along margin of opercle; a series of 4 scales on median line before first dorsal spine. Dorsal spines flexible, spinous portion nearly equaling the soft portion in height; margin of caudal fin convex in the smaller specimens, with lobes not produced; lobes produced in larger ones; height of caudal peduncle 2 in head; pectoral 1.2 in head, its breadth about 1¾ its own length; ventral 1.9 in head, not reaching the vent by a distance equal to half the whole length of the fin, inserted on a vertical through the anterior point of insertion of base of pectoral.

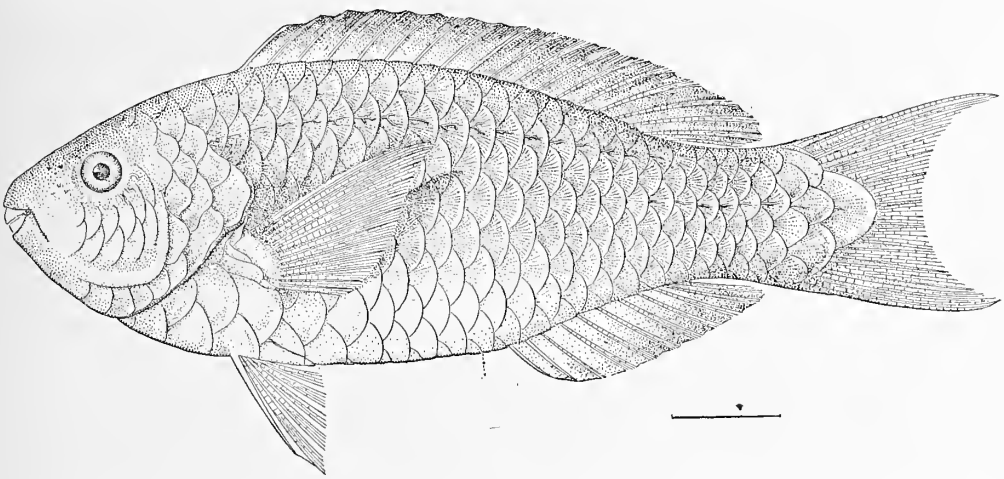


FIG. 16.—*Scarus brunneus* Jenkins, new species. Type.

Coloration in life: Body, head, and vertical fins dusky-brown; pectorals and ventrals lighter; no distinct markings anywhere. This fish appears to be similar to *Scarus dubius* Bennett, whose description is very meager. In that given, it differs in not having scales on anterior limb of the preopercle, in having a pointed tooth at angle of jaw, in having 13 rays in pectoral, and in the caudal not being white on posterior edge.

Type 6139, L. S. Jr. University Museum. Seven specimens were obtained by me. Measurements of three of these are given below:

Scarus brunneus.	No. 1.	No. 2.	No. 3.	Scarus brunneus.	No. 1.	No. 2.	No. 3.
	mm.	*mm.*	*mm.*		*mm.*	*mm*	*mm.*
Total length to middle of caudal	220	185	143	Height of first dorsal spine	18	16	13
Length to base of caudal	182	152	116	Height of soft dorsal rays	22	19	15
Head	62	53	39	Height of soft anal rays	18	17	14
Depth	70	60	43	Ventral	33	29	24
Eye	11	10	8	Pectoral	50	39	30
Snout	24	20	15	Depth of caudal peduncle	30	27	19

Scarus gilberti Jenkins, new species. Fig. 17.

D. IX, 10. A. II, 9 (3 anal spines show on dissection). P. I, 12. Head 2.75 in length to base of caudal, 3.47 in total. Depth 2.44 in length to base of caudal, 3.1 in total. Scales 24; lateral line interrupted; scales slightly roughened by very fine striations of minute tubercles; tubes but little branched. Body deep, compressed. Teeth whitish, lower jaw included. Upper lip double the whole length, covering whole of dental plate; lower lip covering about half of lower dental plate. Two

teeth at posterior angle of upper jaw, one at angle of lower jaw. Cheek with two rows of scales, seven in upper row and 4 to 5 in lower, the margin of one or two scales of lower projecting over anterior limb of preopercle; a series of scales along margin of opercle; a series of 4 scales along median line before first dorsal spine. Dorsal spines flexible; caudal fin middle margin straight, the lobes produced nearly the length of middle portion of fin in longest specimen, less so in smaller ones. Caudal peduncle 2 in head. Pectoral 1.3 in head, its breadth about two-thirds its own length; ventral 1.6 in head, not reaching vent by one-half to one-fourth its length, inserted but slightly back of a vertical from anterior insertion of pectoral.

Color notes from freshly collected specimens not obtained. Specimens in alcohol (evidently much faded) are pale, with upper parts of body somewhat dusky; upper lip greenish-blue, margin of same color. This color from each lip unites behind angle of mouth into a band which extends to anterior margin of eye and passes along lower margin of eye, ending in a small, indistinct (in alcohol) area behind eye; transverse bar of same color across the chin. Back of this, on the throat, are markings of bluish-green; outer margins of dorsal and ventral and upper and lower margins of caudal fins bordered by same color, also anterior margins of pectoral and ventral fins; indistinct markings of same color appear on caudal.

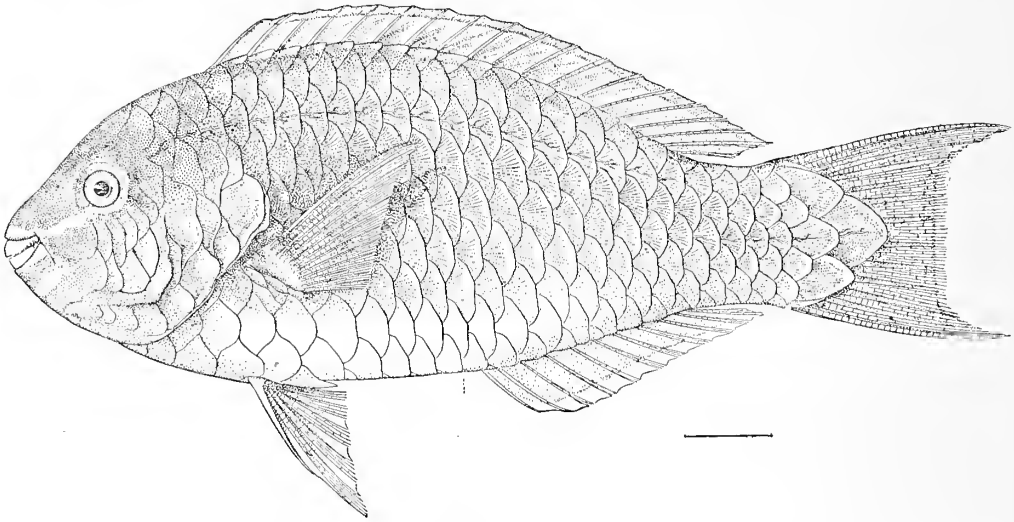


FIG. 17.—*Scarus gilberti* Jenkins, new species. Type.

This species resembles *Scarus octodon* Bleeker. Five specimens were obtained by me in 1889, and one by the *Albatross* in 1896. Type 6140, L. S. Jr. University Museum. The measurements of three are given below:

Scarus gilberti.	No. 1.	No. 2.	No. 3.	Scarus gilberti.	No. 1.	No. 2.	No. 3.
	mm.	*mm.*	*mm.*		*mm.*	*mm.*	*mm.*
Total length to middle of caudal	278	251	318	Snout	32	28	36
Upper lobe of caudal produced beyond above	20	15	30	Height of first dorsal spine	18	16	20
Length to base of caudal	220	208	255	Height of soft dorsal rays	28	28	30
Head	80	70	88	Height of soft anal rays	25	23	26
Depth	90	82	92	Ventral	50	43	59
Eye	12	12	14	Pectoral	54	53	68
				Breadth of caudal peduncle	40	35	42

Scarus paluca Jenkins, new species. Native name, *Palukaluka*. Fig. 18.

Head in body to base of caudal 3, in total to tips of middle caudal rays 3.68. Depth in body to base of caudal 2.8; in total to tips of middle caudal rays, 3.5. D. IX, 10. A. II, 9. P. 14. Scales 24; lateral line interrupted; tubes mostly many-branched, a few single. At interruption two scales with tubes stand immediately above first two of series following interruption; scales very slightly roughened by radiating lines of granulations extending to margins of scales. Body moderately deep,

compressed; profile concave, teeth whitish, lower jaw included, no pointed tooth at angle of either jaw; upper lip double its entire length and covering little more than half of dental plate; lower lip covering half of lower plate. Cheek with 3 rows of scales, 6 in upper row, 4 to 5 in middle, 2 in lower row, which extends upon anterior limb of preopercle; posterior limb of opercle with two series of scales, anterior limb with single series; a series of 6 scales on median line before first dorsal spine. Posterior margin of caudal fin truncate, lobes not produced. Pectoral with 14 rays, its length 1.5 in head, its breadth being more than half its length; ventral 1.85 in head, not reaching vent by two-thirds its own length, its origin but slightly behind a vertical from anterior point of the base of pectoral; dorsal spines flexible, first spine less than the succeeding ones, nearly equaling the soft rays; the soft anal one-sixth higher than soft dorsal.

Coloration in life: Upper portions reddish-brown; lower parts, including ventrals and anal, a brighter red; vertical fins, and ventrals somewhat mottled, but body and head without distinct markings.

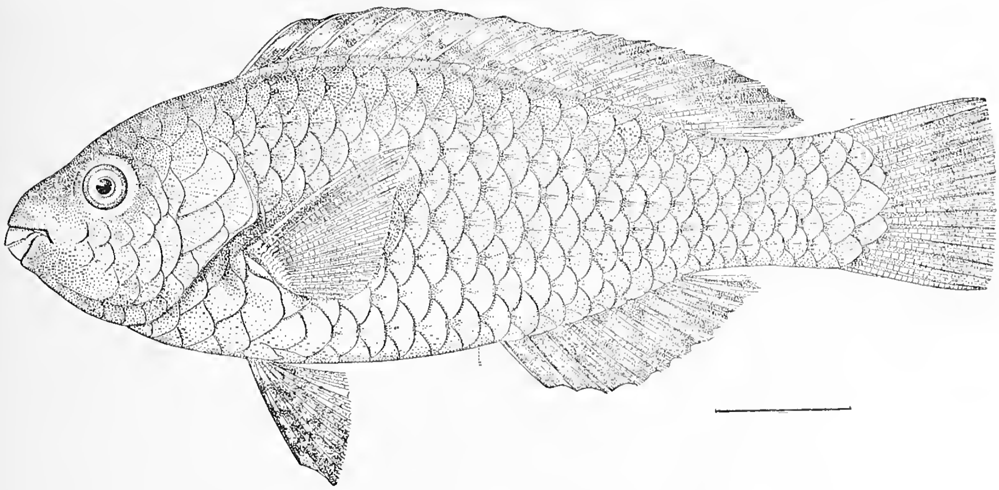


FIG. 18.—*Scarus paluca* Jenkins, new species. Type.

Type No. 6141, L. S. Jr. University Museum. One specimen was obtained by me. This fish is similar to *Scarus rubro-violaceus* (Bleeker), but differs in having 14 rays in pectoral, caudal lobes not produced, markings of fins, and in the absence of markings of body. The specimen gave the following measurements:

Scarus paluca.	Millimeters.	Scarus paluca.	Millimeters.
Total length to middle of margin of caudal	184	Height of first dorsal spine	14
Length to base of caudal	150	Height of soft dorsal	18
Distance of snout to vent	88	Height of soft anal	21
Head	50	Ventral	27
Depth	53	Pectoral	34
Eye	10	Caudal	34
Snout	20	Depth of caudal peduncle	23

Scarus ahula Jenkins, new species. Native names, *U-hu-ula, Pauuhumuhu*. Fig. 19.

Head in length to base of the caudal 2.8, in total length to middle of margin of caudal 3.5. Depth in length to base of caudal 2.34; in total to middle margin of caudal 3. D. IX, 10. A. II, 10. P. 14. Scales 24, lateral line interrupted; tubes single or once or twice branched; scales slightly roughened with very minute granulations extending their margins. Body deep compressed, profile slightly depressed. Teeth whitish, lower jaw included, no pointed teeth at angles of jaws. Upper lip double its entire length and covering about two-thirds of dental plate, lower lip covering about half of lower plate. Cheeks with one row of 4 scales, behind which are 2 scales placed one above the other; preopercle naked, posterior limb of opercle with 2 series, the anterior with 1 series of scales;

a series of 4 scales ou median line in front of first dorsal spine. Caudal fin convex, lobes rounded, length in head 1.26; height of caudal peduncle 2 in head; pectoral 1.35 in head, breadth being more than half its length; ventral 1.8 iu head, not reaching vent by about half its length, inserted on a vertical from posterior limit of base of pectoral; dorsal spiues flexible, but little less in height than soft portion, which equals soft aual iu height.

Coloration in life: Head, body, and fins uniformly browu, with reddish tiuges, which are more pronounced on fins aud throat. Base of caudal paler. No distinct markings on any part of body.

Three specimens obtained by me of a total length of 218, 192, and 156 mm., respectively. One in Dr. Wood's collection is 237 mm. The fish was not rare, as it was frequently seen in market. It is not distinguished from *Scarus paluca* and *brunneus* by the fishermen. They are exposed for sale together and bring very high prices. Type No. 6142, L. S. Jr. Uuiversity Museum.

The details of the measurements of the four examined are given below:

Scarus ahula.	No. 1.	No. 2.	No. 3.	No. 4.	Scarus ahula.	No. 1.	No. 2.	No. 3.	No. 4.
	mm.	*mm.*	*mm.*	*mm.*		*mm.*	*mm.*	*mm.*	*mm.*
Total to middle of caudal	224	192	156	237	Height of first dorsal spine	22	17	17	21
Length to base of caudal	175	152	125	193	Height of soft dorsal	25	22	19	28
Distance of snout to vent	110	98	83	125	Height of soft anal	23	21	18	28
Head	62	55	45	70	Ventral	34	31	27	39
Depth	73	57	47	72	Pectoral	46	40	31	......
Eye	11	10	9	11	Caudal	49	......	31	44
Snout	27	23	18	29	Depth of caudal peduncle	29	24	21	30

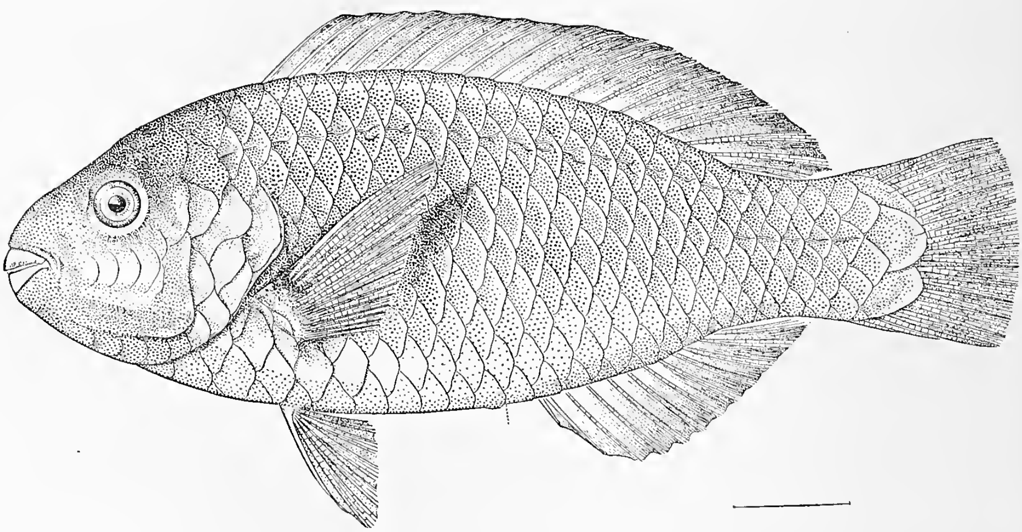


FIG. 19.—*Scarus ahula* Jenkins, new species. Type.

Scarus miniatus Jenkins, new species. Fig. 20.

Head iu length to base of caudal 2.74, iu total length 3.5. Depth in length to base of caudal, 2.6; in total, 3.3. D. IX, 10. A. III, 9. P. 14. Scales 24. Lateral line interrupted. Body robust, deep, compressed. Teeth reddish or white; lower jaw included. A pointed tooth at augle of mouth ou one side, the base of such a tooth only ou other side in one specimen; only the bases of such teeth in angles of mouth in other specimen, the teeth being worn or broken off. Upper lip double only posteriorly, covering about half of deutal plate of upper jaw; lower lip covering about a third of lower dental plate. Cheek with a single row of scales nearly imbedded, in oue specimen so deeply imbedded that they are barely visible; no scales on lower preopercular limb; a series of scales on margin of opercle, those on its lower limbs nearly imbedded. Caudal fin slightly concave, lobes rouuded, not produced; pectoral 1.35 in head, its breadth more thau half its length; ventral half length of head, inserted just back of middle base of pectorals, and failing about half its own leugth of reaching vent; dorsal spines flexible; first few spines of dorsal, anal, and ventral with somewhat fleshy membranes.

Coloration in life: Body, head, and fins a dull red, becomiug a lighter red on lower parts and darker to a dusky reddish-brown on upper portions of body; no distinct markings, except a narrow violet line on outer margins of dorsal and anal fins; iris brown.

The description is based on one specimen, 500 mm. total length, obtained by me in 1887. The measurements are given below. A somewhat smaller specimen obtained by the *Albatross* in 1896 answers to this description in every particular. The fish is apparently not common. It brings an extravagant price among the natives in the market. Type No. 12144, L. S. Jr. University Museum.

The measurements are given below:

Scarus miniatus.	Milli-meters.	Scarus miniatus.	Milli-meters.
Total length	500	Height of longest ray of soft dorsal	55
Length to base of caudal	390	Height of soft anal	45
Head with flap	142	Ventral	70
Depth	152	Pectoral	105
Height of first dorsal spine	35		

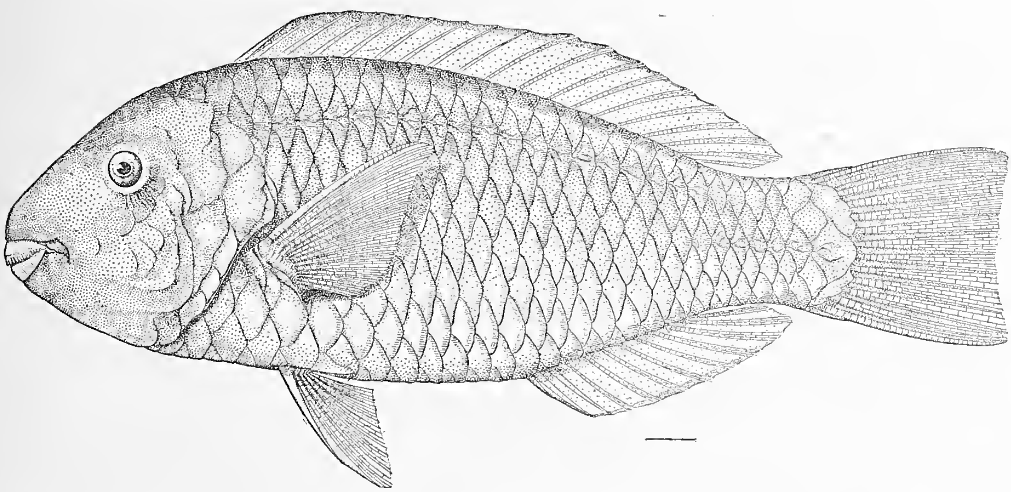


FIG. 20.—*Scarus miniatus* Jenkins, new species. Type.

Pseudoscarus jordani Jenkins, new species. Fig. 21.

Head in length to base of caudal 2.7, in total length to middle margin of caudal 3.37. Depth in length to base of caudal 2.64, in total length to middle margin of the caudal 3.3. Dorsal IX, 10. Anal III, 9. Pectoral 14. Scales 24; lateral line interrupted. In this specimen two scales at the interrupted portion out of the series bear tubes. They are located one each over first two scales in the series following interruption. Tubes much branched; surfaces of scales, except at posterior margin of each, much roughened over the whole body by striations composed of rows of minute tubercles. Body robust and greatly compressed. An adipose lump over snout. Teeth green, lower jaw included; a strong tooth at each angle of upper jaw. Upper lip double only posteriorly, covering more than half of dental plate; lower lip covering less than half of dental plate. Cheek with 3 rows of scales, upper of 7 scales, middle row of 7, the lower row of 2 scales, which extend on lower preopercular limb; a series of scales along entire margin of opercle; a series of six scales on median line before first dorsal spine. Lobes of caudal fin much produced, being longer than body of the fin; height of caudal peduncle in head 2.54. Pectoral 1.5 in head, its breadth being less than half of its own length; ventral 1.75 in head, not reaching vent by one-half its own length, inserted on a vertical from about middle of base of pectoral; dorsal spines flexible; membrane of first few spines of dorsal, anal, and ventral somewhat fleshy on outer margin.

Coloration in life: General color blue, the sides of body and head rosy or pink; region of body just below posterior two-thirds of dorsal and the caudal peduncle green; iris orange; margin of upper lip orange, above which it is bright blue; margin of lower lip blue, below which is an orange area, below this again it is bright blue which changes to a lighter blue; posterior to this a pink area; a pink wavy line from angle of mouth to eye; dorsal fin pink with upper and anterior border blue, and with a blue bar along each spine; anal yellowish with bright blue anterior outer and posterior margins; ventral blue anteriorly and pink posteriorly; caudal, upper and lower borders bright blue, interior portions with reticulations of pink and blue, colors almost wholly disappearing in alcohol;

there remains the green below the postorior two-thirds of dorsal and on caudal peduncle as a pigment on tho scales.

But one specimon of this brilliant fish was obtainod by me, 700 mm. in longth, including lobes of candal. A high price was asked for it indicating that the natives estoem it as food. Typo No. 12143, L. S. Jr. University Museum. The measurements are given below:

Pseudoscarus jordani.	Millimeters.	Pseudoscarus jordani.	Millimeters.
Total length to middle of margin of caudal	600	Snout	85
Length of upper caudal lobe	100	Height of first dorsal spine	30
Length to base of caudal	480	Height of soft dorsal	53
Head	178	Ventral	100
Depth	182	Pectoral	120
Eye	20	Breadth of narrowest portion of caudal peduncle	70

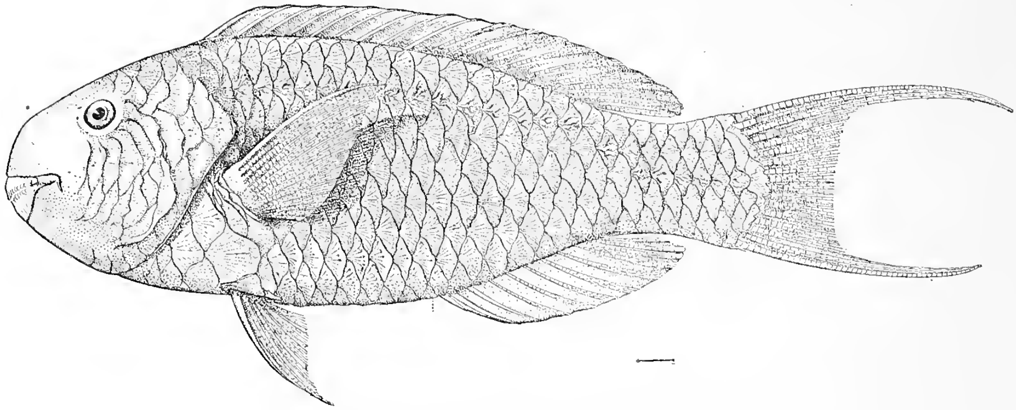


FIG. 21.—*Pseudoscarus jordani* Jenkins, new species. Type.

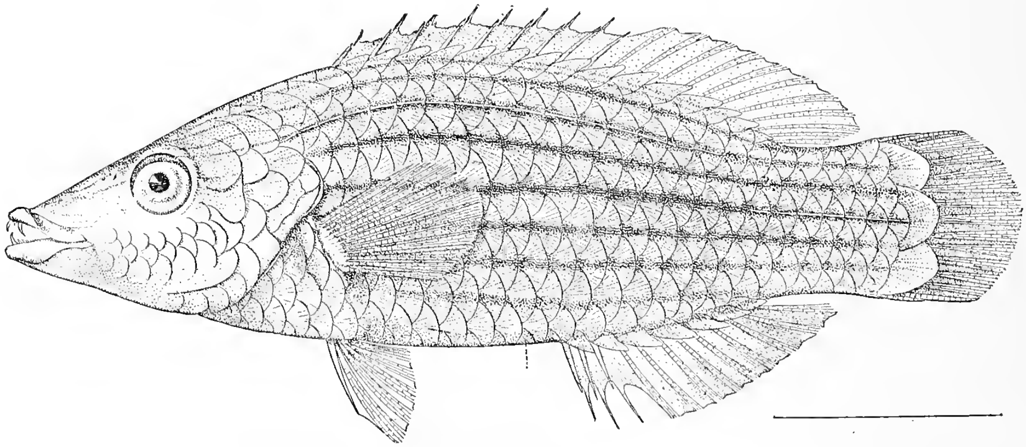


FIG. 22.—*Pseudocheilinus octotænia* Jenkins, new species. Type.

Pseudocheilinus octotænia Jenkins, new species. Fig. 22.

Head in length to middle margin of caudal 3.1, to baso of caudal 2.5. Depth 3.7 (3). D. IX, 11. A. III, 9. Scales 24; latoral line interrupted; tubes single. Body moderately slender, head and snout moderately long, profile slightly concave. Teeth in a single series, no posterior canine; three pairs of large canines in anterior of upper jaw, the posterior pair of which bends outward and backward; one pair of strong canines in anterior of lower jaw. Cheek with mainly two rows of scales; anteriorly the scales are confused, but apparently of three series, encroaching somewhat on preopercle; opercle

with a single series of scales; a series of 5 scales in middle line before dorsal; a series of scales largely sheaths base of dorsal; a similar series sheaths to less extent the base of anal. First dorsal spine shorter than the following, which are subequal, but of less height than soft dorsal; spines pungent, each bearing a produced filament; second anal spine slightly longer than third; soft anal about equal to soft dorsal; caudal rounded, ventral does not reach vent by about half its length; pectoral nearly half of head.

Coloration in formalin: General groundwork pinkish, a conspicuous dark longitudinal band running along center of each row of scales, making eight bands on side of body, the one at base of dorsal through sheathing scales less distinct posteriorly; a similar but narrow band through middle of scales in median line before dorsal spines; faint traces of markings on head; apparently the three upper bands of body extending on to head, the cheeks and lower parts being unmarked. Spines and rays of dorsal and anal blue.

Dr. Bleeker founded the genus *Pseudocheilinus* on a single species described by him as *P. hexatænia*, from Amboyna. This species is included under this genus from its closer relation to *P. hexatænia*, its sole representative, than to *Cheilinus*, as shown in dentition, there being three pairs of strong anterior canines in upper jaw, the third being largest and turning outward and backward. The second anal spine is, however, only slightly longer than third, and the squamation of the cheeks shows anteriorly more than two series.

This description is based on a single specimen, 115 mm. total length. It was obtained by Mr. Keleipio, of Honolulu, for the collection of Dr. Wood in the winter of 1899. Type No. 6122 L. S. Jr. University Museum. The measurements follow:

Pseudocheilinus octotænia.	Millimeters.	Pseudocheilinus octotænia.	Millimeters.
Total length to middle margin of caudal	115	Height of ninth dorsal spine	8
Length to base of caudal	92	Height of soft dorsal	12
Head	37	First anal spine	7
Depth	31	Second anal spine	9
Eye	7	Third anal spine	8
Snout	15	Soft anal	13
Snout to vent	60	Ventral	16
Depth of caudal peduncle	15	Pectoral	20
Height of first dorsal spine	5		

LELAND STANFORD JR. UNIVERSITY, *May 26, 1899.*

CONTRIBUTIONS TO THE BIOLOGY OF THE GREAT LAKES.

ROTATORIA OF THE UNITED STATES, WITH ESPECIAL REFERENCE TO THOSE OF THE GREAT LAKES.*

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INTRODUCTION.

Among the objects to be attained in the biological investigations of the Great Lakes, inaugurated by the United States Fish Commission, a preliminary one is the collection and determination of the animals and plants found in the lakes and the placing of these on record. A portion of the first summer in the field (1898) was spent by the writer in a study of the Rotatoria of the region of Lake Erie about South Bass Island, where the summer laboratory was situated; the observations and collections there made form the basis of the present paper. Three summers had been spent previously by the writer in study of the Rotatoria of other parts of the Great Lakes and of some of the inland lakes of Michigan; other observations in the Great Lakes have been made by Kellicott ('96 and '97) on the Rotatoria of Lake Erie. These researches, taken together, make possible an extended, though of course incomplete, list of the Rotatoria of the Great Lakes. As the work on the Great Lakes has included the larger number of species observed in the United States, it has been deemed advisable, in this first report of work done for the United States Fish Commission, to include a record of all the Rotifera thus far observed in the United States, together with all the localities in which they have been observed, so far as possible. Notices of the Rotifera are scattered through many publications, and it is believed that nothing will serve better as a basis for future work than to bring these scattered notices together.

In beginning a study of a circumscribed group of animals such as the Rotatoria, in connection with a general biological survey of the Great Lakes, it is well to have clearly in mind an outline of the problems upon which work is to be done. The lake is to be looked upon as an organism, the various groups of animals and plants in the lake, as well as the chemical and physical conditions and forces there present, being the organs which make up the whole. These organs are necessarily as closely corre-

* The papers in this series are based on investigations of the U. S. Fish Commission, under the direction of Prof. Jacob Reighard, of the University of Michigan. Three other articles of the series, by the same author, have been published in the American Journal of Physiology, vol. II, 1898 (pp. 311-341, and 355-379), and vol. III, 1900 (pp. 229-260), as follows: (1) The Mechanism of the Motor Reactions of Paramecium; (2) Laws of Chemotaxis in Paramecium; (3) On the Movements and Motor Reflexes of the Flagellata and Ciliata.

lated and adapted to each other as the organs of an animal, and the network of interrelations forms the chief object of study for such a biological survey. Our special problem is to determine just what place the Rotatoria occupy as members of this organic whole. For this a study of the group in all its relations will be necessary. Such a study will follow some such lines as the following:

First, the objects of study must be known and described. To this end there must be on record somewhere full and complete descriptions and figures of all the Rotifera found in the lake, with their correct names. An important preliminary feature of the work consists, therefore, in figuring and describing such forms as have been incorrectly or incompletely described or not described at all. On account of the large number of minute species found among the Rotifera, and the unsatisfactory work that has been done upon many of them, much remains to be accomplished in this line. The best method of carrying on this work will consist in studying carefully circumscribed groups—the species of a single genus, perhaps—describing and figuring all the species, and going critically over the literature of the group in such a way as to set the synonymy in order. Studies of this sort on the genus *Monostyla*, on *Cathypna* and *Distyla*, on *Metopidia*, on *Colurus*, on the *Rattulidæ*, or, for a much more extensive problem, on the *Notommatadæ*, would be exceedingly valuable.

Lists of all the species found in the given body of water must also be placed upon record, in order that the investigator may know with what material he has to deal. Such lists, carefully prepared, are also of much interest for a study of the general problem of the geographical distribution of the group with which we are dealing.

The work above characterized must be considered as purely preliminary to the main object of study; the present paper includes only such preliminary matter. The distribution of the animals within the lake and the study of the conditions under which they live constitute a problem of much greater interest. Most of the species of rotifers seem fitted to some special environmental conditions; what these conditions are may be determined by observation and by experiment. From the side of observation, lists should be kept of Rotifera of the different regions into which a body of water may be divided—distinguishing thus, as is usually done, limnetic species, littoral species, bottom species, and swamp species. This classification is, however, much too general to give precise results. It should be supplemented by a careful study of the Rotifera of regions of different character, with regard to the depth of the water, the character of the bottom, and especially with relation to the plant life of the water. The rotifers from the *Chara* beds, *Ceratophyllum* beds, *Naias* beds, *Potamogeton* beds, the *Cladophora*-covered surfaces, should be studied and listed, to see what relation there is between the animal and plant life of the lake. A beginning of this work was made during the summer of 1898, but in the two months during which the party was in the field not enough could be done, in addition to other work, to permit the drawing of any conclusions, so that the results will not be presented till further study is made.

The changes in the character of the fauna with different seasons of the year and with variations in climate must be studied as an important feature of the conditions of existence. The problem may be attacked more directly under experimental conditions. The animals may be kept in laboratory cultures, and suitable changes produced artificially in the conditions within these cultures. The results of these changes on the life of the animals may thus be observed. Proper control cultures will always be necessary in such work.

The effects of varying conditions in modifying a given single species is a problem

of the greatest interest, leading to the general question of the origin and nature of species and to the deepest questions of morphogenesis. The variations of a given species should be recorded and studied; from a sufficient number of records the laws of the variations may be deduced. More important still is a study of the causes of the variations. The variations occurring with a change of conditions, or with a change of season, are worthy of careful study, such a study as has recently been made by Lauterborn ('98) of *Anuræa cochlearis*. An experimental study of the production of variations promises most for this problem; to this end the very variable and hardy species *Brachionus bakeri* would probably be a most useful form.

The life-history and reproductive habits of the animals furnish a further important field for study. Many features in the life-history of the Rotifera are of much interest and need such study as has been carried on thus far only for *Hydatina senta*, by Maupas, Nussbaum, and others. The striking sexual dimorphism; the conditions of the occurrence of males at certain periods; the determination of the different kinds of eggs produced at different times; the sex of the offspring—all present problems of the greatest interest for an experimental study.

A most important and neglected field lies in a study of the activities by which the animals respond to their environment. Proper conditions of existence are necessary, but these are not sufficient alone to preserve the life of the organisms; the animals must respond to their environment by appropriate activities. We must know what these activities are and the laws which govern them. In other words, a study of the physiology and especially the psychology of the animals is necessary before we can understand the interaction of organism and environment; the functions and movements of the organisms constitute one of the chief factors in the network of interrelations of the "organs" of the lake. Having determined the general laws according to which the organisms respond to their environment—in other words, having made a study of the psychology of the animals—it will then be possible to determine by observation and experiment the specific factors which cause migrations, the sudden appearance of the animals in a given locality, their quick disappearance from another locality, and the like. In any group of animals the investigation must follow some such line as marked out above, in each case a study of the normal psychology of the animals being a prerequisite to an understanding of the laws of their migrations and other striking activities. Commencing at the beginning, a study of this nature was made on the Protozoa during the summer of 1898, the results of which are resumed in another paper, which deals with the Protozoa; it is hoped soon to extend this study to the Rotatoria. The psychology of the Rotatoria has been studied scarcely at all; notes as to the nature of the food and the method of taking it, together with descriptions of the method of forming the tube in some tube-dwelling species, being the chief matters that can be gleaned from the literature.

The only way in which the problems above characterized can be solved, the relations of the Rotifers (or of any other group) to their environment worked out, is for investigators to choose definite limited problems for solution and devote time and energy to observation and experimentation till the questions proposed are answered. Mere isolated observations, collected during a systematic study of the group, can do little; investigators must take up the work in the same spirit in which morphological problems are attacked, concentrating all efforts upon a given point until that is settled. The activities of animals are as worthy of such study as are their structures. Until a large amount of investigation has been done it will not be possible to give any

satisfactory discussion of the place occupied by the Rotatoria in the life system of the lake. In this paper it is only attempted to point out here and there problems that await settlement at the hands of careful investigators.

The paper is, therefore, purely preliminary in character, aiming to show merely what species have thus far been recognized in the United States and where they are found, as well as giving descriptions and figures of some species that are in need of study. Future reports need not take the shape of a formal list, but will give accounts of special studies in any line or record additions to the fauna. Formal lists of species are perhaps the most uninteresting of scientific writings, yet they form a disagreeable necessity as a basis for further work. An ideal list is such a one as that given by Weber ('98) of the Rotatoria of the basin of Lake Geneva, every name accompanied by a beautiful figure of the animal. The short time spent on the work thus far has rendered this impossible for the Rotatoria of the Great Lakes. Most of the figures must be reserved for the future development of the work along this line. In the case of new species, or where there are other causes for special interest, figures are given in the present paper. These figures were drawn by Mrs. Louise Jennings from camera sketches made by the author.

The author has endeavored to avoid, as far as possible, the naming of new species. Since the publication of Hudson and Gosse's Monograph of the Rotifera, about ten years ago, study of this group has been very active, resulting in the multiplication of papers on the subject, often without relation to one another, and describing the same forms under different names. A certain amount of this was perhaps inevitable at first, but heedless work has multiplied the resultant confusion many fold. No one has a right to cumber scientific literature with the names of species "presumably undescribed," as a recent paper naively puts it, without recognizing the fact that a vast volume of literature has appeared on the group since the publication of Hudson and Gosse's Monograph, including descriptions of many new species (295 up to 1897, according to Rousselet, '97). The recognition and description of a new species must therefore be regarded as a most laborious piece of work, involving a careful examination of large numbers of papers in various languages, besides a consultation of Hudson and Gosse. There is no excuse for omitting such a study before publishing descriptions of species as new, in view of the full lists of new rotifers published at intervals by Mr. Charles Rousselet ('93 and '97), with the titles of the papers in which the descriptions are published. If a student finds himself unable to see a large share of these papers it is his duty to recognize the fact that he is not in a position to publish names of new species. If he wishes to publish his notes and drawings, these may be of great use to other workers, but if he proceeds to append new names to his descriptions, increasing the already heavy burden of synonymy, his work becomes a positive injury to science and a nuisance to all careful scientific students. The record of American workers on the Rotifera has not always been so good in this matter as might be wished. In the American paper above referred to as giving names to "presumably undescribed" species, six so-called new species are figured on the plate, with new specific names in the descriptions. Of these six, four are easily recognizable as old friends by anyone familiar with the recent literature of the subject, while the other two are thought by another reviewer to be old species. This illustrates the value of the description of "presumably new" species without comparison with those described in recent papers. Science is burdened with four, perhaps six, new synonyms.

Another mistake to be avoided, as has been emphasized by Rousselet ('96), is the

making of new species because the observer finds some structure not previously figured or described in what would otherwise be considered an old species. It must be recognized that very few of the older figures and descriptions are in any sense complete; it was the purpose of many of the older authors to give merely such a figure and description as would lead to ready recognition of the animal, not to give an exhaustive anatomical account. Moreover, the improvements in optical instruments and in technique have been such as to enable even the amateur to see much that formerly remained hidden to the best investigators.

A third opportunity for the introduction of confusion into the study of the Rotatoria lies in the great variability of many forms. There are few species that are not sufficiently variable to permit an observer to find specimens that differ from the type enough to allow him to immortalize his name by appending it to a synonym, if his ambition runs in that direction. Rousselet ('97) has already pointed out that many of the recent new species are but slight variations of well-known forms. It must be recognized, however, that the limits of variability are not easily defined, and that it is often very difficult to say whether a given specimen should be considered a new species or a variation of an old one. Mistakes from this source are therefore to a certain extent excusable, while those resulting from the first two causes above mentioned are usually due to carelessness or ignorance.

To describe a new species, one should therefore have access to all the papers in which new species have been described since the publication of Hudson and Gosse's Monograph, or at least to all papers describing any species belonging to the genus under consideration. The titles of the papers bearing directly on the genus of which it is proposed to describe a new species may be determined—up to 1897, at least—from Mr. Charles Rousselet's lists of new species of Rotifera (Rousselet '93 and '97). As a further precaution against error, it would be well to submit either mounted specimens or drawings and notes on proposed new species before publication to someone thoroughly competent to judge as to their claims. Mr. Charles Rousselet, 2 Pembridge Crescent, Bayswater, London W., England, is doubtless as well acquainted with the Rotifera as anyone in the world, and is always willing, with uniform courtesy and kindness, to give expert advice as to the publication of what seem to be new species.

On account of the recent great multiplication of new species, a description of a new rotifer should be accompanied by a careful comparison with any other species of the same genus that at all nearly resemble it and the points of difference brought out clearly. In a number of recent cases the lack of ground for giving a new name would at once have been evident if this had been done. For example, Stenroos ('98) in his recent valuable paper on the animal life of Lake Nurmijärvi, in Finland, after describing as new *Cathypna magna* n. sp., gives a list of the known species of Cathypna, among them *Cathypna ungulata* Gosse. A careful comparison of *Cathypna magna* Stenroos with *Cathypna ungulata* Gosse would have disclosed their identity.

The publication of a new species without a figure, which has been practiced by some American authors, as well as by some of those of Europe, is greatly to be deprecated. Usually the figure is the most important part of the account of a rotifer, and a description could, as a rule, be much better dispensed with than a good figure.

To sum up, therefore, anyone who proposes to publish a description of a rotifer as new should fulfill the following conditions:

1. Not only Hudson and Gosse's Monograph, but all subsequent papers containing descriptions of rotifers in any way related to the one in hand, should be consulted.

2. New species should not be described as a result of the discovery of some hitherto unmentioned anatomical detail in an otherwise known species.

3. Great care should be exercised not to describe as new species mere variations of an old species.

4. If any doubt can possibly exist, the figures and descriptions should be submitted, before publishing, to some expert who has all the literature at hand.

5. A description of a new species should be accompanied by a detailed comparison with any very closely related species that may exist, to show wherein this one differs and why it is considered new.

6. Every description of a new species should be accompanied by a good figure or figures.

For the two cases in which it has seemed necessary to describe certain forms as new in the present paper, an attempt has been made to fulfill these conditions.

The subjoined list contains not only the species found by the author in Lake Erie, in the region of South Bass Island in the summer of 1898, but also, so far as known to the writer, all the species that have been found in the United States, together with the localities from which each species has been recorded. An attempt has been made to make this list as complete as possible, but the references to the Rotatoria are exceedingly scattered, so that I can not hope that none have been overlooked. Nevertheless it is believed that the omitted references are very few.

A brief review of the history of the study of the Rotatoria in this country may be of interest in this connection. The first recorded observation of any member of the group in America seems to be that of Bosc (1802), who observed some rotifer belonging to the *Philodinidæ* in Carolina. Ehrenberg in his great work ('38) held Bosc's animal to have been *Rotifer vulgaris*, while in a later paper (Ehrenberg, '43) he considers it to have been probably *Callidina rediviva* Ehr.

The next notice of American Rotatoria that I have been able to find is that by Ehrenberg ('43). He lists a few rotifers observed by him in material sent to him from this country by various men of science.

In 1855 Bailey ('55) described *Limnias annulatus* Bailey.

Schmarda ('59) in his trip around the world, 1853 to 1857, observed two rotifers "in brackish water near New Orleans."

From this time on, up to 1879, little notice of the Rotifera is to be found in American journals, save a few notes by Leidy ('51, '57, '74, and '74*b*) and one by Peirce ('75), in the Proceedings of the Academy of Natural Sciences of Philadelphia.

In 1879 the late Dr. D. S. Kellicott published his first note on the Rotifera, a description of *Notholca longispina* Kellicott. This was followed by many other papers on the group, up to the year before the death of this author in 1898. The decade from 1880 to 1890 was marked by numerous brief papers and notes on the group, by Kellicott, Herrick, Leidy, Attwood, Vorce, Forbes, Foulke, Stokes, Up de Graff, and others. The first formal list of American species was that of Herrick ('85) of rotifers found in Ohio and Minnesota, followed with one by Kellicott ('88) of rotifers found at Corunna, Mich.

In the decade now coming to an end, work on the group has been much increased, especially in connection with the founding of fresh-water biological stations. Extended local lists of species have been published by Turner ('92), the present writer ('94 and '96), Kellicott ('96 and '97), and Hempel ('98).

In the following list those species representing the autnor's investigations of Lake Erie during the summer of 1898 are numbered consecutively; those not observed here are not numbered. After each locality is given the name of the investigator who has recorded it, followed by numerals showing the year in which the publication took place. The exact reference may then be determined by turning to the list of literature at the end of the paper, where the authors' names are arranged alphabetically, and the papers of a given author are distinguished by prefixing to each the number of the year (in the century) in which it was published. In certain cases species are recorded in proceedings of societies as having been exhibited by some member of the society; in every such case the citation is given under the name of the member who made the exhibit. In some cases I have recorded here for the first time localities other than Lake Erie in which I have at some time observed a species; these localities are signed with my own initials (H. S. J.).

The region studied by the author during the summer of 1898 consisted of the waters about South Bass Island, especially the waters of the lake along the shore of the island. Naturally the waters in the immediate neighborhood of Put-in Bay were most carefully examined, since the laboratory was situated on the shore of this bay. Many excursions, however, were made to more distant regions. East Harbor, south of the island, on the northern shore of Ohio, furnished many of the rotifers. Others came from towings made in Lake Erie at a distance from shore. Two swamps on South Bass Island were carefully examined; one lies close to the United States fish-hatchery, while the other lies on the east shore of the island, just east of the village of Put-in Bay. The latter is referred to in the list as "East Swamp." The swamp near the fish-hatchery is connected with the lake by a channel about 50 feet long, and is situated at such a level that at times water flows from the lake into the swamp, while again it flows from the swamp into the lake; therefore, as might be expected, the limnetic rotifers of the lake sometimes occur in the swamp, while at other times the fauna of the swamp is of the most pronounced stagnant-water type. East Swamp has no connection with the lake.

The proper classification of the Rotatoria presents great difficulties. The system most in use is that of Hudson and Gosse, as given in their Monograph of the Rotifera. This classification is unsatisfactory in many ways, and what I consider a better one in many respects has recently been proposed by Lund ('99). After consideration it was decided, however, not to introduce this new classification into the present paper, as most workers on the group are now better acquainted with the classification given by Hudson and Gosse, so that the use of their system will best facilitate reference to the list. The sequence of orders, families, and genera adopted is therefore that of Hudson and Gosse, in the Monograph of the Rotifera published in 1889, with some modifications rendered absolutely necessary by more recent investigations.

A LIST OF ALL ROTATORIA HITHERTO FOUND IN THE UNITED STATES, AND THE LOCALITIES WHERE THEY HAVE BEEN OBSERVED, WITH DESCRIPTIONS OF TWO NEW SPECIES.

[Accompanied by plates 14–22, figs. 1–46.]

Order I. RHIZOTA.

Much less study has been given to the Rhizota, or attached Rotifera, by the present writer, than to the free-swimming forms, and the same seems to be true of other students of American Rotatoria. Doubtless much remains to be done before even an approximately full list of the American Rhizota can be given, and some of the forms already listed are sadly in need of careful study. There is much room for work in preparing full and accurate descriptions and figures of the American Rotifera of this group.

ıily 1. FLOSCULARIADÆ.

FLOSCULARIA Oken.

1. **F. cornuta** Dobie.

On *Elodea* from East Harbor, Lake Erie.

Pond near Bangor, Me. (J. C. S., '83). Nigger Creek, Grand Island, Niagara River (Kellicott, '87). Shiawassee River at Corunna, Mich. (Kellicott, '88). Chippewa Lake, Mecosta County, Mich., and Lake St. Clair (Jennings, '94). Sandusky Bay, Lake Erie, and Buffalo, N. Y. (Kellicott, '96).

2. **F. algicola** Hudson.

On *Cladophora* and *Chara*, in East Swamp, South Bass Island.

The specimens found agreed perfectly with the description given by Hudson in the small size (210μ=0.01 inch in length), in the dots on the corona arranged in symmetrical patterns, and in other respects; but they inhabited evident tubes, while Hudson was unable to find a tube.

3. **F. mutabilis** Bolton.

This free-swimming form seems widely distributed in waters of the Great Lakes, although it is never present in large numbers. It was frequently taken with the tow net and plankton net in the open lake about South Bass Island, in Lake Erie. Also found in a swamp close to United States fish-hatchery on South Bass Island, at times when the water of the lake flowed into the swamp.

Lake St. Clair (Jennings, '94). Lake Michigan, Pine Lake, Round Lake, and West Twin Lake, near Charlevoix, Mich. (Jennings, '96). Sandusky Bay, Lake Erie (Kellicott, '96).

4. **F. pelagica** Rousselet.

The distribution of *F. pelagica* is about the same as that of *F. mutabilis*. I found it in collections made with the tow net and plankton net in Lake Erie at various places near South Bass Island. It is noteworthy that neither of these limnetic *Floscularias* have been reported from the carefully studied waters of the Illinois River.

Lake St. Clair (Jennings, '94). Lake Michigan, Round Lake, and Pine Lake, near Charlevoix, Mich. (Jennings, '96).

5. **F. millsii** Kellicott.

A single specimen attached to a *Difflugia* shell, from the Portage River, Ohio, about a mile from Lake Erie.

Black Creek, Ontario, Canada (Kellicott, '85). Nigger Creek, Grand Island, Niagara River (Kellicott, '87). Sandusky Bay, Lake Erie (Kellicott, '97). Also found by Mr. J. B. Shearer at Bay City, Mich. (according to Kellicott, '97).

F. ornata Ehrenberg.—Pond near Bangor, Me. (J. C. S., '83). "American species" (Kellicott, '84). Minnesota (Herrick, '85). Nigger Creek, Grand Island, Niagara River (Kellicott, '87). Shiawassee River at Corunna, Mich. (Kellicott, '88). Exhibited in New York (Helm, '89 and '91). In the neighborhood of Cincinnati, Ohio (Turner, '92). Chippewa Lake, Mecosta County, Mich., and Lake St. Clair (Jennings, '94). Sandusky Bay, Lake Erie (Kellicott, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

F. campanulata Dobie.—Black Creek, Ontario, Canada (Kellicott, '85). Nigger Creek on Grand Island, Niagara River (Kellicott, '87). Shiawassee River at Corunna, Mich. (Kellicott, '88). West Twin Lake, Muskegon County, Mich.; McLaren Lake, Occana County, Mich. (Jennings, '94). West Twin Lake, near Charlevoix, Mich. (Jennings, '96). Sandusky Bay, Lake Erie (Kellicott, '96).

F. edentata Collins.—McLaren Lake, Oceana County, Mich.; Chippewa Lake, Mecosta County, Mich.; Crooked Lake, Newaygo County, Mich. (Jennings, '94). Small pond at Cedar Point, Sandusky, Ohio (Kellicott, '97). Swamp near Norwich, Vt. (H. S. J.).

F. ambigua Hudson.—Shiawassee River, Corunna, Mich. (Kellicott, '84 and '88). Sandusky Bay, Lake Erie (Kellicott, '96).

F. coronetta Cubitt.—"American species" (Kellicott, '84). Shiawassee River at Corunna, Mich. (Kellicott, '88).

F. trilobata Collins.—Pond near Bangor, Me. (J. C. S., '83, under the name *F. trifolium*). Corunna, Mich. (Kellicott, '84, as *F. trifolium*).

F. regalis Hudson.—Found by Up de Graff at Elmira, N. Y. (according to Kellicott, '84).

Acyclus inquietus Leidy.—Schuylkill River, near Philadelphia (Leidy, '82).

APSILUS Metschnikoff.

(Plate 14, figs. 1 and 2.)

What seems to be the young free-swimming form of a species of this genus was found sparingly amid *Lemna*, *Spirodela*, and *Wolffia* in the swamp near the United States fish-hatchery, on South Bass Island, in July, 1898. It is not possible to determine the species of young specimens from the published descriptions of the members of this genus, because they deal entirely with the adult. In my paper of 1894 I assumed that this was *A. lentiformis* Metsch., that being the only species recognized as certainly well established by Hudson and Gosse. But if Stokes ('96*c*) is correct in his contention that four species of the genus are to be recognized, then this may belong to any of them. A thorough study of the animal was undertaken, but they disappeared before this was completed; I give my notes and drawings, however, so far as they go. A side view, accurate as far as it goes, but not showing all details, is given in fig. 1.

The body is thick and clumsy and slightly curved, so as to be convex dorsally and concave ventrally. It tapers slightly toward both ends, ending in a truncate fashion, at the anterior end in the head, at the posterior end in the broad disk which serves as a foot. The head is separated from the body dorsally by a slight depression, while ventrally the outline of the body continues uninterruptedly into the head. The posterior disk is marked off from the body by a broad shallow constriction. The animal is very transparent and entirely colorless, except for the two red eyes.

The ciliated face at the anterior end is slightly oblique, a non-ciliated part projecting above the ciliated portion. The cilia are rather long and seem to form a simple circle, but observations on this point are not complete. A large lobed brain lies behind the corona, bearing in front the two red eyes, in which crystalline lenses are clearly visible. The head may be extended considerably farther than is shown in the figure, or may be entirely retracted.

The body of the animal is filled with a bewildering confusion of glands, digestive organs, muscles, and nerve cords. Much of interest might be brought out by a minute study of these parts; I have seen no rotifer that appeared so favorable for a study especially of the muscular and nervous systems. The figure, accurate so far as it goes, gives an idea of the complex of details awaiting disentanglement. I shall not, in the absence of minute study, attempt to interpret the structures shown. The prominent trophi lie, as in other members of this genus, at the bottom of a large sac; they are of the peculiar form characteristic of the genus. They are shown in fig. 2, plate 14.

The body wall seems much more complex than is usually the case in the Rotifera. It appears to be possible to distinguish four layers, beginning with the outside: (1) A thin cuticula; (2) a thick, gelatinous cellular layer; (3) a layer of transverse muscles; (4) a layer of longitudinal muscles. The two muscular layers are not completely separated, and some of the longitudinal muscles traverse the body cavity, but in a general way the distinction into two layers is evident. The posterior disk is retractile into a sort of mantle which partly covers it, and the whole, mantle and all, may be drawn within the body. The disk is concave, with lines radiating from the deeper central portion, and is ciliated. The movements of the animal much resemble those of Asplanchna.

Lund ('99) holds that *Apsilus* should be removed from the *Floscularidæ* and placed in a separate family near the *Asplanchnadæ*.

The present author ('94) recorded this same form from Lake St. Clair as *A. lentiformis* Metsch.

A. vorax Leidy.—Schuylkill River and Fairmount Park, Philadelphia (Leidy, '57, '82, and '84).

A. bipera Foulke.—Fairmount Park, Philadelphia (Foulke, '84). Pool at Trenton, N. J. (Stokes, '96*c*). Sandusky Bay, Lake Erie (Kellicott, '97).

A. bucinedax Forbes.—In an aquarium at Normal, Ill. (Forbes, '82). Pool at Trenton, N. J. (Stokes, '96*c*).

A. lentiformis Metsch.—In Phipps Conservatory tanks at Allegheny, Pa. (Logan, '95).

Stephanoceros eichhornii Ehrenberg.—Philadelphia ? (Peirce, '75). Bangor, Me. (J. C. S., '83). Ponds in New Jersey (Balen, '83 and '85). Found by E. B. Grove in Rogers Glen, Oneida, N. Y., by W. R. Cross at Camden, Me., and by C. F. Park near Poughkeepsie, N. Y., according to Balen ('83). In Canada, across from Buffalo, N. Y. (Kellicott, '84). Pittsburg, Pa. (Mellor, '89). Exhibited in New York (Cox, '89, and Helm, '97). McLaren Lake, Oceana County, Mich., and Horsehead Lake, Mecosta County, Mich. (Jennings, '94). Sandusky Bay, Lake Erie (Kellicott, '97).

Family 2. MELICERTADÆ.

MELICERTA Schrank.

6. **M. conifera** Hudson.

East Swamp, South Bass Island, on *Characeæ*.

Shiawassee River at Corunna, Mich. (Kellicott, '88). Sandusky Bay, Lake Erie (Kellicott, '96).

M. ringens Schrank.—Niagara River (Fell, '82). Bangor, Me. (J. C. S., '83). New Jersey (Balen, '85). Shiawassee River at Corunna, Mich. (Kellicott, '88). Exhibited in New York (Helm, '89, and Walker, '94). Exhibited in San Francisco (Breckenfeld, '89). Lake St. Clair and West Twin Lake, Muskegon County, Mich. (Jennings, '94). Phipps Conservatory tanks at Allegheny, Pa. (Logan, '95). Susan Lake, North Michigan (Jennings, '96). Black Channel, Sandusky Bay, Lake Erie (Kellicott, '97).

M. janus Hudson.—In the following inland lakes of Michigan: McLaren Lake, Oceana County; Crooked Lake, Newaygo County; Horsehead Lake, Mecosta County; Chippewa Lake, Mecosta County (Jennings, '94). Mr. John Hood has recently called my attention to the fact that the *Melicerta flocculosa*, described (without a figure) by Kellicott ('96), from Sandusky Bay, resembles in almost, if not quite, every respect *M. janus*, except in the possession of a tube without pellets. Now, Mr. Hood finds *M. janus* in Scotland inhabiting tubes without pellets, so that there is a strong probability that he is right in believing Kellicott's *M. flocculosa* to be really *M. janus*. Kellicott's description of *M. flocculosa* is so meager that it is difficult to find facts upon which to base a positive opinion; the only point in the description of *M. flocculosa* which might be held not to coincide with that of *M. janus* is that Kellicott says the chin is spatulate, whereas in Hudson's description the chin is said to be two-pointed. It will probably be best to consider *M. flocculosa*, at least provisionally, as a synonym of *M. janus*.

M. tubicolaria Ehr.—Exhibited in New York (Helm, '89). Sandusky Bay, Lake Erie (Kellicott, '97).

M. flocculosa Kellicott.—See *M. janus*.

Limnias ceratophylli Schrank.—"Abundant in our rivers" (Leidy, '74). Pond near Bangor, Me. (J. C. S., '83). Shiawassee River at Corunna, Mich. (Kellicott, '88.) Sandusky Bay, Lake Erie, and Niagara River (Kellicott, '96). Exhibited in New York (Helm, '97). Waters connected with Illinois River at Havana, Ill. (Hempel, '98).

L. shiawasseensis Kellicott.—Shiawassee River at Corunna, Mich. (Kellicott, '88). Sandusky Bay, Lake Erie (Kellicott, '96).

L. annulatus Bailey.—West Point, N. Y. (Bailey, '55). Shiawassee River at Corunna, Mich. (Kellicott, '88). Sandusky Bay, Lake Erie (Kellicott, '96).

L. socialis Leidy = *L. ceratophylli* Schrank.

Cephalosiphon limnias Ehrenberg.—Along shore of Niagara River (Mills, '81). Buffalo, N. Y., and Shiawassee River Michigan (Kellicott, '87). Corunna, Mich. (Kellicott, '88). Olentangy Creek at Columbus, Ohio (Kellicott, '89). Lake St. Clair (Jennings, '94). Sandusky Bay, Lake Erie (Kellicott, '96). Waters connected with Illinois River at Havana, Ill. (Hempel, '98).

C. candidus Hudson.—Olentangy Creek, Columbus, Ohio (Kellicott, '89).

C. furcillatus Kellicott = *Œcistes melicerta* Ehrenberg.

Œcistes melicerta Ehrenberg.—Olentangy Creek at Columbus, Ohio (Kellicott, '89, under the name *Cephalosiphon furcillatus*). Swamp on the shore of Lake St. Clair (Jennings, '94). This species is represented by Stokes ('81, fig. 2) without a name, probably from New Jersey. The two dorsal hooks are developed in many specimens into two great branched antler-like structures, which are shown in plate 14, fig. 3. There seems to be no justification for the change of the specific name from *melicerta*, as given by Ehrenberg, to *ptygura*, as given by Hudson and Gosse.

O. longicornis Davis.—Shiawassee River at Corunna, Mich. (Kellicott, '88). Lake St. Clair and McLaren Lake, Oceana County, Mich. (Jennings, '94). Sandusky Bay, Lake Erie (Kellicott, '96). Exhibited in New York (Helm, '97).

O. mucicola Kellicott.—Shiawassee River at Corunna, Mich. (Kellicott, '88). Sandusky Bay, Lake Erie (Kellicott, '96). West Twin Lake, near Charlevoix, Mich. (Jennings, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

O. crystallinus Ehrenberg.—Shiawassee River at Corunna, Mich. (Kellicott, '88). Sandusky Bay, Lake Erie (Kellicott, '96).

O. umbella Hudson.—Sandusky Bay, Lake Erie (Kellicott, '97).

O. intermedius Davis.—Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

Lacinularia socialis Ehr.—Exhibited in New York (Balen, '85; Damon, '86 and '88). Shiawassee River at Corunna, Mich. (Kellicott, '88). Pond near Norris Pass, on the Shoshone Trail, Yellowstone Park (Forbes, '93). Sandusky Bay, Lake Erie (Kellicott, '96). West Twin Lake near Charlevoix, Mich. (Jennings, '96). Much less common than *Megalotrocha alboflavicans*. It seems probable that the latter is often mistaken for it.

MEGALOTROCHA Ehrenberg.

7. **M. alboflavicans** Ehrenberg.

Very abundant on *Chara* in East Swamp, South Bass Island.

Along shore of Niagara River (Mills, '81, under name *M. flavicans*). Schuylkill River, Pennsylvania (Leidy, '82, under name *M. alba*). Pond near Bangor, Me. (J. C. S., '83). Exhibited in New York (Helm, '94). Lake St. Clair; Mona Lake, Muskegon County, Mich., and Horsehead Lake, Mecosta County, Mich. (Jennings, '94). Sandusky Bay, Lake Erie (Kellicott, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

M. semibullata Hudson.—Waters connected with Illinois River at Havana, Ill. (Hempel, '98).

TROCHOSPHÆRA Semper.

8. **T. solstitialis** Thorpe.

Swamp near United States fish-hatchery, South Bass Island, in August, 1898.

The genus *Trochosphæra* was instituted by Semper in 1872 (*Zeitschr. f. wiss. Zool.*, Bd. 22, p. 311) for the remarkable rotifer *Trochosphæra equatorialis* Semper, found by that author in the Philippine Islands. *Trochosphæra equatorialis,* as is well known, is a spherical rotifer, with a girdle of cilia dividing the surface of the sphere into two hemispheres. It approaches closely, in many respects, to the structure of the Trochophora larva of annelids and mollusks, and great importance has been attached to it as the nearest representative of the hypothetical ancestor of those groups. *Trochosphæra* seems not to have been seen again until found by Surgeon V. Gunson Thorpe, of the English Navy, in 1889, at Brisbane, Australia. In 1892 the same investigator discovered in China a second species of the same genus, differing from *T. equatorialis* in that the ciliary girdle passes not around the middle of the sphere, but nearer one pole, like the tropic of Cancer around the earth. To this species Thorpe ('93) gave the appropriate specific name *solstitialis*. Much interest was aroused when in 1896 (Science, Dec. 25, 1896) Kofoid announced the discovery of *T. solstitialis* Thorpe in the Illinois River and waters connected therewith near Havana, Ill. Kofoid raised the question whether its presence in America was due to recent importation from China, or whether it is to be considered a native American form. Its occurrence at a station so distant from that recorded by Kofoid, on a small island in Lake Erie, seems to indicate that the latter alternative is probably correct. It is not unlikely that *Trochosphæra* will be found to be widely distributed in America when proper search for it is made.

The swamp in which *Trochosphæra* occurred at Put-in Bay has over its bottom a dense growth of *Ceratophyllum,* while the surface is completely covered with a mantle of plant material consisting of *Lemna, Spirodela,* and *Wolffia* intermixed. It is connected with the lake by a narrow short channel, and is situated at such a level that when the lake is high it receives water from the lake, while under the usual conditions water flows out of the swamp into the lake. Many of the Rotifera in the swamp are common to it and to the lake, while a number were found in the swamp alone; among the latter was *Trochosphæra.* The animal was never abundant, only a few individuals being obtained, and it was found for only a few days in August.

Waters connected with the Illinois River at Havana, Ill. (Kofoid, '96, and Hempel, '98).

CONOCHILUS Ehrenberg.

9. **C. unicornis** Rousselet.

Common in surface towings and plankton hauls from Lake Erie in the region of South Bass Island and from East Harbor.

Lewis Lake and Yellowstone Lake in the Yellowstone Park (Forbes, '93, under the name *C. leptopus* Forbes). Lake St. Clair (Jennings, '94). Sandusky Bay, Lake Erie (Kellicott, '97). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

C. volvox Ehrenberg.—Water from Plainfield, N. J. (Hitchcock, '81 *b*). Bangor, Me. (J. C. S., '83). Exhibited in New York (Balen, '85, Helm, '89, and Walker, '94). Quincy Bay, Mississippi River, Illi-

nois (Garman, '90, p. 182). Lake St. Clair and Chippewa Lake, Mecosta County, Mich. (Jennings, '94). Sandusky Bay, Lake Erie (Kellicott, '96). West Twin Lake, near Charlevoix, Mich. (Jennings, '96). Van Cortlandt Lake, New York City (Helm, '97).

C. dossuarius Hudson.—Sandusky Bay, Lake Erie (Kellicott, '97). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

C. leptopus Forbes = *C. unicornis* Rousselet.

"*Apœcia amelia.*"—In the Journal of the New York Microscopical Society, vol. 13, 1897, on p. 15, among the "objects exhibited" occurs the following: "Rotifer, *Apœcia amelia*, living, from New Jersey, by Frederick Kato." Further on occurs the following: "Mr. Walker said of Mr. Kato's rotifer, that it is mentioned in Trans. Acad. Nat. Sci. of Phil., and is the same as Mr. A. D. Balen's rotifer of "pond 61," 2½ miles from Westfield, N. J." I have not been able to discover any reference to a rotifer with this generic or specific name elsewhere, though I myself and others have searched carefully through the publications of the Philadelphia Academy for an account of the animal. Through the kindness of Dr. Emily G. Hunt, however, I am able to present the following facts: The rotifer was discovered by Dr. W. Gibbons Hunt, of Philadelphia, about twenty years ago, on the under side of partially decayed water-lily leaves, in a lake in New Jersey. "It was a very large and unusually beautiful rotifer, existing in colonies, the individuals of which had the tails all attached to one common point and radiated out on all sides in a sphere, the whole embedded in a clear jelly." Dr. Hunt named the rotifer *Apœcia æmilia*, and is supposed to have published somewhere a description of the new genus and species thus founded; this description, if it exists, it seems impossible now to trace. From the above description it is apparent that the animal belonged to the Rhizota.

Order II. BDELLOIDA.

Family 3. PHILODINADÆ.

PHILODINA Ehrenberg.

10. P. roseola Ehrenberg.

One of the commonest of the Rotifera; abundant among the plants of the bottom of Lake Erie in the region studied. This rotifer was one of the few species found in the small landlocked pools on the rocky surface of Starve Island, just south of South Bass Island.

Pond near Bangor, Me. (J. C. S., '83). Shiawassee River at Corunna, Mich. (Kellicott, '88). Pools in the neighborhood of Cincinnati, Ohio (Turner, '92). Lake St. Clair and the following inland lakes of Michigan: White Lake, Muskegon County; Crooked Lake, Newaygo County; Chippewa Lake, Mecosta County (Jennings, '94). Sandusky Bay, Lake Erie (Kellicott, '96). In old channel connecting Round Lake and Pine Lake, near Charlevoix, Mich. (Jennings, '96).

11. P. citrina Ehrenberg.

Bottom of Put-in Bay Harbor and East Harbor, Lake Erie; also in the swamp near the fish-hatchery on South Bass Island.

Lake St. Clair and the following inland lakes of Michigan: White Lake, Muskegon County; McLaren Lake, Oceana County, and Crooked Lake, Newaygo County (Jennings, '94). Sandusky Bay, Lake Erie (Kellicott, '96). Trenton, N. J.? (Stokes, '96*a*). Round Lake and swamp on the shore of Pine Lake, near Charlevoix, Mich. (Jennings, '96). Common in pools, Hanover, N. H. (H. S. J.).

12. P. megalotrocha Ehrenberg.

Common in bottom vegetation of Lake Erie in the region of South Bass Island. Also from East Harbor and the small pools on Starve Island.

Pool in the neighborhood of Cincinnati, Ohio (Turner, '92). Lake St. Clair (Jennings, '94). Sandusky Bay, Lake Erie (Kellicott, '96). Pine Lake, near Charlevoix, Mich. (Jennings, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

13. P. aculeata Ehrenberg.

Swamp near United States fish-hatchery, South Bass Island.

Shiawassee River at Corunna, Mich. (Kellicott, '88). Lake St. Clair and McLaren Lake, Oceana County, Mich. (Jennings, '94). Sandusky Bay, Lake Erie (Kellicott, '96). Trenton, N. J. (Stokes, '96*a*). Tamarack swamp on shore of Pine Lake, near Charlevoix, Mich. (Jennings, '96). Apparently the species described by Stokes ('81), as "*Philodina* n. sp.?."

P. macrostyla Ehrenberg.—Lake St. Clair (Jennings, '94). Bottom of Lake Michigan, and pool on the shore of Pine Lake at Charlevoix, Mich. (Jennings, '96). I have lately found it in some *Utricularia* sent from Norfolk, Va. Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

ROTIFER Schrank.

14. R. vulgaris Schrank.

Common among the plants of the bottom of Lake Erie about South Bass Island and in East Harbor; also from the two swamps on the island.

In dirt from the crevices of pavements of Philadelphia (Leidy, '74 *b*). Summit of Roan Mountain, North Carolina (Leidy, '80). Lake Erie (Vorce, '82). Pond near Bangor, Me. (J. C. S., '83). Exhibited in New York (Mitchell, '86, Helm, '89). Shiawassee River at Corunna, Mich. (Kellicott, '88). Pools near Cincinnati, Ohio (Turner, '92). Lake St. Clair and various inland lakes of Michigan (Jennings, '94). Sandusky Bay, Lake Erie (Kellicott, '96). Pine Lake, near Charlevoix, Mich. (Jennings, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98). Hanover, N. H. (H. S. J.).

15. R. tardus Ehrenberg.

Abundant in the swamps on South Bass Island and in East Harbor, Lake Erie; also in Portage River, Ohio. The specimens found in this region had the spurs much shorter and thicker than are figured by Hudson and Gosse ('89) and Janson ('93). In every other respect, however, it was exactly Ehrenberg's *R. tardus*. I have since seen at Hanover, N. H., specimens having the long narrow spurs figured by Gosse and Janson.

Shiawassee River at Corunna, Mich. (Kellicott, '88). Lake St. Clair (Jennings, '94). Sandusky Bay, Lake Erie (Kellicott, '96). Pool on the shore of Pine Lake at Charlevoix, Mich. (Jennings, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

R. macroceros Gosse.—Shiawassee River at Corunna, Mich. (Kellicott, '88). Lake St. Clair (Jennings, '94). Sandusky Bay, Lake Erie (Kellicott, '96).

R. elongatus Weber.—Bogs, Corunna, Mich. (Kellicott, '92). Bottom of Lake Michigan in the neighborhood of Charlevoix, Mich. (Jennings, '96).

R. trisecatus Weber.—Lake St. Clair and pools on shore of Pine Lake near Charlevoix, Mich. (Jennings, '94 and '96).

R. mento Anderson.—Lake St. Clair (Jennings, '94).

R. neptunius Ehrenberg.—Pittsburg, Pa. (Mellor, '88). Lake St. Clair (Jennings, '94). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

R. macrurus Schrank.—Shiawassee River at Corunna, Mich. (Kellicott, '88). Sandusky Bay, Lake Erie (Kellicott, '96). Waters connected with Illinois River at Havana, Ill. (Hempel, '98). Very abundant in water from a ditch at Hanover, N. H. (H. S. J.).

Callidina papillosa Thompson. Swamp on shore of Pine Lake near Charlevoix, Mich. (Jennings, '96).

C. constricta Duj.—With the last (Jennings, '96).

C. magna Plate.—With the last (Jennings, '96).

C. musculosa Milne.—Bottom of Lake Michigan near Charlevoix, Mich. (Jennings, '96).

C. eremita Bryce.—Swamp 5 miles from Norwich, Vt. (H. S. J.).

C. elegans Ehrenberg.—Doubtfully reported by Kellicott ('96) from Sandusky Bay, Lake Erie. Waters connected with Illinois River at Havana, Ill. (Hempel, '98).

C. socialis Kellicott.—On the larva of *Psephenus lecontei*, Shiawassee River at Corunna, Mich. (Kellicott, '88).

C. redivira Ehrenberg?—North Carolina, Bosc. (See Ehrenberg, '43.)

Family 4. ADINETADÆ.

Adineta vaga Davis.—Tamarack swamp, on shore of Pine Lake, near Charlevoix, Mich. (Jennings, '96).

Order III. PLOIMA.

Sub-Order ILLORICATA.

Family 5. MICROCODONTIDÆ.

Microcodon clavus Ehrenberg.—Pond near Bangor, Me. (J. C. S., '83). Crooked Lake, Newaygo County, Mich. (Jennings, '94). West Twin Lake, near Charlevoix, Mich. (Jennings, '96).

Microcodides orbiculodiscus Thorpe.—Lake St. Clair (Jennings, '94). Pool on shore of Pine Lake, near Charlevoix, Mich. (Jennings, '96). Pond in sand on shore of Sandusky Bay, Sandusky, Ohio (Kellicott, '97, under the name *M. dubius* Bergendal).

Family 6. ASPLANCHNADÆ.

ASPLANCHNA Gosse.

16. A. priodonta Gosse.

In towings from Lake Erie. Not abundant.

Pond in Buffalo City Park (Kellicott, '87). Abundant in Lake St. Clair (Jennings, '94). Lake Michigan, Round Lake, and Pine Lake, near Charlevoix, Mich. (Jennings, '96). Sandusky Bay, Lake Erie (Kellicott, '97). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

A. herrickii de Guerne.—It is characteristic of the poorness of the plankton in Rotifera, in Lake Erie, about South Bass Island, that *Asplanchna herrickii* was not found there at all in the summer of 1898, and that *A. priodonta* was not abundant. In previous examinations of Lake St. Clair and Lake Michigan both had been found very abundant. This species was first figured by Herrick ('84, plate v, fig. 8) from Minnesota, under the title "flask-shaped rotifer, hermaphrodite, with eggs and sperm." Other localities where it has since been found in America are as follows: Lake St. Clair (Jennings, '94); Lake Michigan, Round Lake, Pine Lake, and Susan Lake, in north Michigan (Jennings, '96); waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

A. brightwellii Gosse.—Neighborhood of Cincinnati, Ohio (Turner, '92, under the name *A. cincinnatiensis* Turner). Phipps Conservatory tanks at Allegheny, Pa. (Smiley, '95). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

A. ebbesbornii Hudson.—Pond near Philadelphia (Leidy, '87). Waters connected with the Illinois River, at Havana, Ill. (Hempel, '98).

A. girodi de Guerne.—Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

A. amphora Hudson.—Found at Philadelphia by Leidy, according to Hudson and Gosse, '89 (Supplement, p. 13).

A. cincinnatiensis Turner = *A. brightwellii* Gosse.

A. magnificus Herrick = *Asplanchnopus myrmeleo* Ehr.

ASPLANCHNOPUS De Guerne.

17. A. myrmeleo Ehrenberg.

East Swamp, South Bass Island. Many.

Minnesota (Herrick, '84, under the title "deadly enemy to Chydorus," and '85, under the name *Asplanchna magnificus* n. sp.). Pine Lake and West Twin Lake, near Charlevoix, Mich. (Jennings, '96). Marshes in the region of Sandusky, Ohio (Kellicott, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

Ascomorpha ecaudis Perty (*Sacculus viridis* Gosse).—Shiawassee River at Corunna, Mich. (Kellicott, '88). Lake St. Clair and Whitmore Lake, near Ann Arbor, Mich. (Jennings, '94). Round Lake, near Charlevoix, Mich. (Jennings, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

There seems to be some question as to the proper specific name of this animal. According to de Guerne ('88) Perty's name *ecaudis* has the priority, dating from 1850. But Weber, '98, in his recent very careful paper, uses the name *helvetica*, likewise credited to Perty, without giving the date of this name, though he cites also the name *ecaudis* as a synonym. Perty's papers have not been at my command in order to settle the uncertainty.

A. hyalina Kellicott.—Pool at Corunna, Mich. (Kellicott, '88). Lake St. Clair and Whitmore Lake, Mich. (Jennings, '94). West Twin Lake, near Charlevoix, Mich. (Jennings, '96).

A. orbicularis Kellicott.—"Biemüllers Cove," Sandusky Bay, Lake Erie (Kellicott, '97). Weber ('98) holds that this species was described from contracted examples of *Gastropus stylifer* Imhof (*Notops pygmæus* Calman). This appears not improbable.

HERTWIGIA Plate.

18. H. parasita Ehrenberg.

In *Volvox* from East Swamp, South Bass Island.

A rotifer parasitic in *Volvox*, and therefore doubtless this species, has been recorded from Paterson, N. J. (N. N., '75), and from Hyde Park, Chicago, Ill. (Attwood, '78). It has also been recorded by name from Sandusky Bay, Lake Erie, and Minerva Park, Columbus, Ohio (Kellicott, '97). I have also found it in the reservoir of the town water supply of Hanover, N. H. (H. S. J.). Though often placed with the *Notommatadæ*, the opinion expressed by many authors that this creature is more nearly related to *Ascomorpha* is probably correct, so that it seems best to place it here in close juxtaposition with that genus.

Family 7. SYNCHÆTADÆ.

SYNCHÆTA Ehrenberg.

19. S. stylata Wierzejski.

Rather rare in the harbor of Put-in Bay, Lake Erie. Few in the swamp near the fish-hatchery on South Bass Island at times when the lake water has poured into the swamp.

Lake St. Clair (Jennings, '94). Lake Michigan, Round Lake, Pine Lake, and West Twin Lake, near Charlevoix, Mich. (Jennings, '96). Sandusky Bay, Lake Erie (Kellicott, '97). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

S. pectinata Ehrenberg.—Pond near Bangor, Me. (J. C. S., '83). Whitmore Lake, Washtenaw County, Mich. (Jennings, '94). Sandusky Bay, Lake Erie (Kellicott, '97). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

S. tremula Ehrenberg?—Doubtfully reported by Kellicott ('97) in marsh water in the neighborhood of Sandusky, Ohio.

Family 8. TRIARTHRADÆ.

POLYARTHRA Ehrenberg.

20. P. platyptera Ehrenberg.

One of the commonest of the Rotatoria. Abundant in surface and bottom towings and in collections of plants from the bottom of Lake Erie in the region of South Bass Island, and from East Harbor. Also in the two swamps on South Bass Island.

Lake Erie (Vorce, '82). Near Minneapolis, Minn. (Herrick, '85). Shiawassee River at Corunna, Mich. (Kellicott, '88). Lake St. Clair; Chippewa Lake, Mecosta County, Mich.; Whitmore Lake, Washtenaw County, Mich. (Jennings, '94). Sandusky Bay, Lake Erie (Kellicott, '96). Lake Michigan, Round Lake, Pine Lake, and West Twin Lake, near Charlevoix, Mich. (Jennings, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

P. platyptera var. *euryptera* Wierzejski.—Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

Anarthra aptera Hood.—Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

TRIARTHRA Ehrenberg.

21. T. longiseta Ehrenberg.

Swamp near United States fish-hatchery on South Bass Island. Few.

Water from Lake Erie at Sandusky, Ohio (Kellicott, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

Pedetes saltator Gosse.—Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

Family 9. HYDATINADÆ.

Hydatina senta Ehrenberg.—This large and interesting rotifer is said to be common in Europe, but in all the waters which I have examined for rotifers in this country *Hydatina* has been conspicuously absent. But it has been reported by Kellicott ('88) from the Shiawassee River at Corunna, Mich., and by Hempel ('98) from waters connected with the Illinois River at Havana, Ill.

NOTOPS Hudson.

22. N. clavulatus Ehrenberg.

Numerous at times in the swamp near the United States fish-hatchery on South Bass Island, in company with *Trochosphæra solstitialis*. Also in East Swamp.

There seem to be no very exact figures of the ciliary apparatus of this species; for the sake of comparison with *Notops pelagicus* n. sp. (see the next) I have made a study of it and present herewith a figure (plate 15, fig. 10). The corona of *Notops clavulatus* consists of the following parts: A circle of large cilia extends around the circumference of the head, interrupted (if at all) only at the mouth on the ventral side. The ventral half of this crown of cilia approaches a semicircle in form, but laterally there is a notch on each side, and the dorsal half is much less regular. Within this outer coronal wreath are three large styligerous prominences surrounding the buccal funnel, corresponding with the three prominences of *N. pelagicus*, and doubtless also with those of *N. brachionus*. The dorsal one of the three prominences is smaller than in *N. pelagicus*, and bears six long styles sheathed at the base, of the sort described and figured by Hudson and Gosse as occurring in *N. brachionus*. The two

lateral prominences bear ten (or sometimes nine?) similar styles. To right and left of the dorsal median prominence are two small bundles of very slender bristles. These take the place of the two large single styles in *N. pelagicus*. As is well known, such large single styles are often formed of cilia or small styles united in bundles; this is probably the case in *N. pelagicus*, so that it is not surprising to find a large style in the one species corresponding to a bundle of small styles in the other. The buccal funnel descends directly from the lateral styligerous prominences; on its lateral walls are two elevations, each bearing five styles that project horizontally across the furrow through which the food passes. These correspond exactly with the two elevations in the buccal funnel of *N. pelagicus* (fig. 8) and with those described by Hudson and Gosse for *N. brachionus*.

Thorpe ('93) has described as a new species *Notops lotos*, from China; the only difference between this and *N. clavulatus* is that the former has but three styligerous prominences on the corona, whereas Hudson says that "*N. clavulatus* has a greater number of styligerous lobes" than *N. brachionus*, which he says has three (Hudson and Gosse, '89, vol. II, p. 12). Hudson's figure shows in *N. clavulatus* some six or seven or more of such lobes (vol. I, plate XV, fig. 3). But it is difficult to say how exact Hudson's figure was meant to be in this respect. From the figure it is not possible to say which structures represent styligerous prominences and which parts of the outer ciliary wreath, and the impression is given that the exact number and position of the prominences was not clear in the mind of the author. Such being the case, it has seemed most probable to me that my specimens are *N. clavulatus*, though but three large and two small "styligerous prominences" exist. Moreover, the two small prominences to right and left of the median one are very easily overlooked, and it seems to me possible that they were thus overlooked by Thorpe, and that his specimens were also *N. clavulatus*. Some exact information as to the corona of the typical *N. clavulatus* of Europe would be a valuable contribution from some of the European workers in this field. It is possible that such information may show that our form should be given Thorpe's new name *Notops lotos*, but I think this highly improbable. In case this should turn out to be *N. lotos* Thorpe, it is worthy of remark that it was found here, as Thorpe found it in China, along with *Trochosphæra solstitialis*.

23. N. pelagicus n. sp. (Plate 15, figs. 7, 8, and 9.)

This interesting new member of the limnetic fauna of Lake Erie occurred rather sparingly in surface and bottom towings and plankton hauls from parts of Lake Erie in the neighborhood of the group of islands about Put-in Bay.

On the first examination of this rotifer the generic affinities are puzzling. It has in many respects the general aspect of a *Brachionus*, seeming, like *N. brachionus*, to form a connecting link between the genera *Notops* and *Brachionus*. Its closest affinities are apparently with *Notops brachionus* Ehr., but with its partially loricated body it seems to resemble very closely also the *Brachionus mollis* of Hempel ('96). Through the kindness of Dr. C. A. Kofoid, superintendent of the Illinois Biological Station, I have been able to examine the type specimens of *Brachionus mollis*. While the resemblance between the two is striking, Hempel's species is clearly a *Brachionus*, while this is as evidently a *Notops*. The body is thick and clumsy, the dorsal surface rising in a regular arch from both ends to the middle (as seen in side view), the ventral surface nearly flat, but its posterior third sloping upward to join the dorsal surface (fig. 7). A ventral view shows a broad surface, widest some distance from the rear, thence narrowing suddenly backward to a blunt point (fig. 8). The coronal surface is so prone as to seem to form an almost direct continuation of the surface of the body. A short unringed foot with two inconspicuous toes completes the animal posteriorly.

The integument is thickened to form a partial lorica, much as in *N. hyptopus* Ehr., to judge from the account given by Hudson and Gosse. In front the loricate nature of the integument is extremely evident, the dorsal edge having even four short teeth, as in species of *Brachionus* or *Anuræa*, while at the junction of the dorsal and ventral parts of the lorica there are in front two marked teeth or angles. The anterior ventral edge is nearly smooth, there being merely a rounded notch at its middle point. The corona can be partly withdrawn within the lorica, giving exactly the appearance of an *Anuræa* or *Brachionus*, with partly retracted corona—the edges of the lorica with its teeth standing out sharp and clear. Over the remainder of the animal the integument is merely stiffened, much as in some of the large species of *Diglena*, forming thus certain permanent folds. A pair of such folds extends backward from the head on either side, separating the lorica into dorsal and ventral portions (fig. 7). Just in front of the base of the foot a transverse fold passes across from one lateral fold to the other (fig. 8), seeming to set a posterior limit to the ventral plate. Yet the entire lorica, if it is to be so called, is pliable, not forming an unyielding shell as in the typically loricate Rotifera, and especially is the posterior region soft and yielding, so that there is no sheath or any indication of lorica about the place of attachment of the foot. Above the foot the body projects backward in a

thick point (fig. 7), yet this is comparable in texture merely to the "tail" of *Copeus pachyurus*, rather than to a projection of the lorica, such as occurs in a *Brachionus*.

A little above the two lateral longitudinal folds above mentioned there is a broad longitudinal depression, above which the arched dorsal part of the body is much less in width than the ventral part. This depression is indicated by a strip of deeper shading along the side in fig. 7.

The corona (fig. 8), is of the typical *Notops* character, resembling in all essential details that of *N. clavulatus*, just described, and in many respects very closely that of *N. brachionus*, as figured by Western ('90). A nearly circular outer ciliary wreath is interrupted on each side by an ear-like unciliated projection, with a deep notch in front of it; there is also a short ventral unciliated region. Within this wreath are three curved styligerous prominences about the buccal funnel; these correspond in position to the three main prominences in *N. clavulatus* and, I should judge, to the middle dorsal and the two ventral prominences shown by Western ('90) in *N. brachionus*. The exact number of styles on each of these prominences was not noted, so that the figure does not attempt to be accurate on that point. At the side of the middle prominence, between it and the lateral prominences, are two thick styles or antennæ, taking the place of the two bunches of small cilia to right and left of the middle prominence in *N. clavulatus*. The ciliated buccal funnel descends from within the three prominences; some distance within there are on the sides two small elevations, each with a number of stiff setæ extending transversely across the buccal groove, exactly as in *N. clavulatus*. As previously mentioned, the coronal surface is very nearly a direct continuation of the ventral surface of the animal, so that a ventral view permits a thorough study of the corona. A thick dorsal antenna projects from a notch in the anterior dorsal margin of the lorica, exactly as in *Brachionus*. Lateral antennæ were not observed.

The foot is short and thick, and is quite without annulations. It is scarcely at all extensible, varying little in length, so far as observed. The two toes are very inconspicuous, at times retracted, so as to be quite invisible. Each ends in a minute tube, through which at times a thick mucus is exuded, by means of which the animal adheres to objects with which it comes in contact. A broad canal can be traced from each toe to a group of small glands at the base of the foot. The trophi (fig. 9) are malleate, agreeing in all essentials with those of *N. clavulatus* as figured by Wierzejski ('93) and Gosse ('56). Each uncus contains five broad blunt teeth. On each side of the mastax, situated apparently in some portion of the alimentary canal, there is—in many specimens at least—a bright red spot, the two making almost the appearance of eyes. The large brain, triangular in side view, carries at its posterior dorsal point the single large red eye. The other internal organs were not studied.

The egg is carried by the mother, attached just above the base of the foot, in exactly the position in which a *Brachionus* carries its eggs.

Notops pelagicus feeds upon the unicellular algæ which float in the clear waters of the lake and form the primary food supply of almost all the water organisms. Thus, if we consider the organisms of the lake as forming a chain, of which these unicellular algæ, deriving their sustenance directly from the inorganic constituents of the water, are the first link, while the highest carnivorous fish are the last, this rotifer forms a part of the second link, standing in relations of dependency only to the primal source of food supply.

Notops pelagicus is noteworthy for its bearing upon the classification of the Rotatoria. It seems to belong unquestionably to *Notops*, and to be more closely related to the soft-bodied members of that genus; yet it has an evident partial lorica. In spite of this lorica, it clearly does not belong at all with those loricate members of the (former) genus *Notops* that have recently been separated off by Weber ('98) as *Gastropus*. Its relations are not with *Gastropus stylifer*, *G. minor*, and *G. hyptopus*, but with *Notops clavulatus* and *N. brachionus*; at the same time, it is evidently related to the species of *Brachionus*. I believe with Lund ('99) that the Hydatinadæ are to be grouped naturally with the Brachionidæ, and that the softness or stiffness of the cuticula (upon which depends whether the animal is called loricate or illoricate) is a character of little significance in classification.

It is to be noted that in the two important papers that have appeared most recently on the Rotatoria, the species of the genus *Notops* have been divided in the same manner, but that the name *Notops* has been left with a different division in each case. Both Weber ('98) and Lund ('99) separate *Notops clavulatus* and *N. brachionus* on the one hand from *N. hyptopus*, *N. minor*, and *N. stylifer* (*pygmæus*) on the other. But while Weber leaves the name *Notops* to the former group, calling the others *Gastropus*, Lund gives the name *Notops* to the *hyptopus* group, relegating the others to *Hydatina*. I have followed Weber, for reasons given under the discussion of the genus *Gastropus*.

N. minor Rousselet; *N. pygmæus* Calman.—See *Gastropus*, under Loricata.

N. laurentinus Jennings.—See *Proales laurentinus* Jennings.

TRIPHYLUS Hudson.

24. T. lacustris Ehrenberg.

This rare and interesting rotifer occurred abundantly in East Swamp, South Bass Island, both the male and the female being found. Western ('92) gives a figure of the male of this species.

CYRTONIA Rousselet.

25. C. tuba Ehrenberg.

East Swamp, South Bass Island, abundant.

Trenton, N. J. (Stokes, '97, under name *Proales hyalina* n. sp.).

Family 10. NOTOMMATADÆ

Albertia naidis Bousfield.

Lake St. Clair (Jennings, '94).

It seems possible that the *Anelcodiscus pellucidus* described by Leidy ('51), from the intestine of *Stylaria fossularis* Leidy, in the neighborhood of Philadelphia, may have been a rotifer of this genus.

TAPHROCAMPA Gosse.

26. T. annulosa Gosse. (Plate 14, figs. 4, 5, and 6.)

Swampy parts of East Harbor, Lake Erie; common.

There is so much characteristic detail about the form and structure of this animal that is not brought out in the published figures, that I have thought it worth while to give some camera figures of specimens killed in extension. Fig. 4 gives a side view. The animal is here represented as curved more than other published figures show it, but in my experience this is about the form the living specimen usually has when moving along the bottom. On account of the fact that it is so curved, the entire body can not well be shown in a single dorsal view. Fig. 6 gives a dorsal view of the anterior three-fourths of body, while fig. 5 gives a corresponding view of the posterior three-fourths, showing the toes, with the broad tail above them. In regard to the internal anatomy, it needs to be said that the intestine does not open in the broad dorsal depression near the posterior end of the body, as Weber ('98) has represented it, but the opening lies just above the toes, beneath the tail. Mr. Gosse's statement in the monograph that the opening of the intestine is *beneath* the two toes is equally incorrect. This is perfectly clear in mounted specimens.

Shiawassee River at Corunna, Mich. (Kellicott, '88). Lake St. Clair, and the following inland lakes of Michigan: McLaren Lake, Oceana County; Crooked Lake, Newaygo County; Chippewa Lake, Mecosta County (Jennings, '94). Channel between Round and Pine Lakes, near Charlevoix, Mich. (Jennings, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

27. T. saundersiæ Gosse.

Portage River, Ohio, among *Utricularia.*

Shiawassee River at Corunna, Mich. (Kellicott, '88). Lake St. Clair (Jennings, '94).

28. T. selenura Gosse.

East Harbor, Lake Erie and swamp near fish-hatchery on South Bass Island.

Lake St. Clair (Jennings, '94). Trenton, N. J. (Stokes, 96*a*).

T. clavigera Stokes.—Trenton, N. J. (Stokes, '96*b*).

PLEUROTROCHA Ehr.

29. P. parasitica n. sp. (Plate 16, figs. 13 and 14.)

Parasitic on the annelid *Nais lacustris,* from among plants of the bottom of Lake Erie about South Bass Island.

In waters connected with the Great Lakes I have several times noticed a *Pleurotrocha* attached by its jaws to the external surface of the small annelid *Nais lacustris.* The first one observed I thought I could identify with Ehrenberg's *P. constricta* (Jennings, '94, p. 14), but I have since been able to make a more careful study, with the result of showing that this identification is wrong, the body being much too short and broad. It resembles more nearly *P. gibba* Ehr., yet is clearly distinguished from that species by the much greater size of the toes, as well as by the totally different form of the body and head. It resembles no other of the recently described species of this genus, so that it is necessary to describe it as a new species. Ventral and side views of the animal are shown in plate 16, figs. 13 and 14.

Body very short and broad, oval in dorsal or ventral view. Head much narrower than body, tapering to the obliquely truncate corona, composed of a single wreath of cilia. Body truncate behind; from the lower side of the truncate surface rises the single joint forming the short foot. The two tapering toes are about as long as the body is thick at the posterior end; they stand some distance apart at base. The internal anatomy offers nothing especially noticeable save the lack of an eye, which is of course the character that places this form in the genus *Pleurotrocha*. Length, 110μ. Animal ectoparasitic on the annelid *Nais lacustris*.

Pool near Lake St. Clair (Jennings, '94, under the name *Pleurotrocha constricta* Ehr.).

NOTOMMATA Gosse.

30. N. aurita Ehrenberg.

Rare, among plants on bottom of Put-in Bay Harbor, Lake Erie.

Lake St. Clair (Jennings, '94). Sandusky Bay, Lake Erie (Kellicott, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

31. N. tripus Ehrenberg.

East Harbor, Lake Erie, in *Utricularia*.

Shiawassee River at Corunna, Mich. (Kellicott, '88). Lake St. Clair and White Lake, Muskegon County, Mich. (Jennings, '94). Trenton, N. J. (Stokes, '96 *b*, under name *N. mirabilis* n. sp.). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98). Brook, Hanover, N. H. (H. S. J.).

32. N. truncata Jennings.

In *Naias* and *Chara*, bottom of Put-in Bay Harbor, Lake Erie.

Lake St. Clair (Jennings, '94). This species has recently been found by Stenroos ('98) in Finland.

N. brachyota Ehrenberg.—Lake St. Clair (Jennings, '94).

N. collaris Ehrenberg.—Lake St. Clair (Jennings, '94).

N. torulosa Duj.—Lake St. Clair and Chippewa Lake, Mecosta County, Mich. (Jennings, '94).

N. monopus Jennings.—Lake St. Clair (Jennings, '94). Lake Michigan, Round Lake, Pine Lake, West Twin Lake, and Susan Lake, near Charlevoix, Mich. (Jennings, '96).

N. vorax Stokes.—Trenton, N. J. (Stokes, '97). Sandusky Bay, Lake Erie (Kellicott, '97).

N. cyrtopus Gosse.—Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

N. mirabilis Stokes.=*N. tripus* Ehr.

N. lacinulata Ehrenberg., see *Diaschiza lacinulata* Ehrenberg.

COPEUS Gosse.

33. C. pachyurus Gosse.

Bottom of shallow parts of Lake Erie near Put-in Bay.

Tamarack swamp on the shore of Pine Lake, near Charlevoix, Mich. (Jennings, '96). Reservoir of the water supply, Hanover, N. H. (H. S. J.).

C. labiatus Gosse.—Shiawassee River at Corunna, Mich. (Kellicott, '88). Lake St. Clair (Jennings, '94). Pine Lake, near Charlevoix, Mich. (Jennings, '96). Brook, Hanover, N. H. (H. S. J.).

C. ehrenbergii Gosse.—Sandusky Bay, Lake Erie (Kellicott, '97).

C. cerberus Gosse.—Lake St. Clair and the following inland lakes of Michigan: McLaren Lake, Oceana County; Crooked Lake, Newaygo County; Chippewa Lake, Mecosta County (Jennings, '94). Sandusky Bay, Lake Erie (Kellicott, '96).

C. quinquelobatus Stokes.—Trenton, N. J. (Stokes, 96*c*). I have found a *Copeus* at Hanover, N. H., having five lobes to the brain, but agreeing in every other particular with *C. pachyurus;* this also seems true of Stokes's *C. quinquelobatus*. But the specimens at Hanover occurred along with typical specimens of *C. pachyurus*, having but three lobes to the brain; moreover, the specimens with five lobes were a little larger than those with three lobes. I can not but think it probable that *C. pachyurus* develops another pair of lateral lobes on the brain as it becomes larger, and that the species *quinquelobatus* is founded on such specimens. This is rendered the more probable by the fact that in the specimens seen the development of the two lateral lobes varied greatly.

C. americanus Pell.—Locality not given by describer, but probably Highland Falls, N. Y. (Pell, '90).

PROALES Gosse.

34. P. sordida Gosse.

Bottom of Put-in Bay Harbor, Lake Erie.

Lake St. Clair (Jennings, '94). Sandusky Bay, Lake Erie (Kellicott, '96).

P. felis Ehrenberg.—Lake St. Clair (Jennings, '94).

P. werneckii Ehrenberg.—In *Vaucheria* from ponds along Paxton Creek, Harrisburg, Pa. (Wolle, '82 and '87). Lake St. Clair; rivulet at Ann Arbor, Mich. (Jennings, '94).

P. laurentinus Jennings.—Lake St. Clair (Jennings, '94, as *Notops laurentinus*). Channel between Round Lake and Pine Lake, and in West Twin Lake, near Charlevoix, Mich. (Jennings, '96).

P. decipiens Ehrenberg.—Sandusky Bay, Lake Erie (Kellicott, '96.)

P. gibba Ehrenberg.—Sandusky Bay, Lake Erie (Kellicott, '96).

P. algicola Kellicott.—Sandusky Bay, Lake Erie (Kellicott, '97).

P. hyalina Stokes = *Cyrtonia tuba* Ehr.

FURCULARIA Ehrenberg.

35. **F. forficula** Ehrenberg. (*F. trihamata* Stenroos, '98).

Very abundant in bottom and littoral vegetation of shallow parts of Lake Erie about South Bass Island.

Shiawassee River at Corunna, Mich. (Kellicott, '88). Lake St. Clair and the following inland lakes of Michigan: McLaren Lake, Oceana County; Chippewa Lake, Mecosta County; Round Lake, Mecosta County (Jennings, '94). Pine Lake, near Charlevoix, Mich. (Jennings, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

36. **F. longiseta** Ehrenberg.

Common among water plants in East Harbor, Lake Erie.

Shiawassee River at Corunna, Mich. (Kellicott, '88). Lake St. Clair and the following inland lakes of Michigan: White Lake, Muskegon County; McLaren Lake, Oceana County; Crooked Lake, Newaygo County; Chippewa Lake, Mecosta County (Jennings, '94). Sandusky Bay, Lake Erie (Kellicott, '96). Pool on the shore of Pine Lake; West Twin Lake, near Charlevoix, Mich. (Jennings, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98). Swamp near Norwich, Vt.; pond, Hanover, N. H. (H. S. J.).

37. **F. semisetifera** Glasscott.

In *Chara* from East Swamp, South Bass Island.

Hood ('95) holds that this species is identical with *Furcularia eva* of Gosse. My specimens did not have the large anterior dorsal hump which Gosse mentions in his description and figures prominently, so that I feel it necessary to accept Miss Glasscott's name, the specimens agreeing with her figures.

Pool on the shore of Pine Lake near Charlevoix, Mich. (Jennings, '96).

F. gracilis Ehrenberg.—Shiawassee River at Corunna, Mich. (Kellicott, '88). Lake St. Clair (Jennings, '94). Pool on the shore of Pine Lake near Charlevoix, Mich. (Jennings, '96).

F. gibba Ehrenberg.—Lake St. Clair; Chippewa Lake, Mecosta County, Mich. (Jennings, '94).

F. micropus Gosse.—Pool on the shore of Pine Lake, near Charlevoix, Mich. (Jennings, '96).

Triophthalmus dorsualis Ehrenberg.—Round Lake and Pine Lake, near Charlevoix, Mich. (Jennings, '96).

EOSPHORA Ehr.

38. **E. aurita** Ehrenberg.

East Swamp, South Bass Island; Portage River, Ohio.

Lake St. Clair (Jennings, '94). Round Lake, Charlevoix, Mich. (Jennings, '96). Sandusky Bay, Lake Erie (Kellicott, '97). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

DIGLENA Ehr.

39. **D. grandis** Gosse.

Bottom vegetation of Lake Erie about South Bass Island and East Harbor.

Lake St. Clair (Jennings, '94). Old Channel and West Twin Lake, near Charlevoix, Mich. (Jennings, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

40. **D. forcipata** Ehrenberg.

In *Naias* from bottom of Put-in Bay Harbor and East Harbor, Lake Erie.

Lake St. Clair, and Chippewa Lake, Mecosta County, Mich.; Crooked Lake, Newaygo County, Mich. (Jennings, '94). Old Channel, Charlevoix, Mich. (Jennings, '96). Sandusky Bay, Lake Erie (Kellicott, '97).

41. **D. catellina** Ehrenberg.

Bottom of Put-in Bay Harbor, Lake Erie; land-locked pools on Starve Island.

Round Lake, Charlevoix, Mich. (Jennings, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

42. D. biraphis Gosse.

Swamp near fish-hatchery, South Bass Island.

Lake St. Clair, and Chippewa Lake, Mecosta County, Mich. (Jennings, '94). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

D. circinator Gosse.—Chippewa Lake, Mecosta County, Mich. (Jennings, '94).

D. caudata Ehrenberg.—McLaren Lake, Oceana County, Mich. (Jennings, '94).

D. contorta Stokes.—Trenton, N. J. (Stokes, '97).

Distemma forficula Ehrenberg.—Pond near Bangor, Me. (J. C. S., '83).

Suborder LORICATA.

Family 11. RATTULIDÆ.

There is much confusion in regard to the identification of the species belonging to this family, so that I have thought it best to give figures of the species listed, so far as possible. The group is badly in need of a thorough revision.

MASTIGOCERCA Ehrenberg.

43. M. bicornis Ehrenberg. (Plate 17, fig. 15).

East Harbor, Lake Erie.

Pond near Bangor, Me. (J. C. S., '83). Lake St. Clair, and Chippewa Lake, Mecosta County, Mich. (Jennings, '94). Round Lake, and Pine Lake, Charlevoix, Mich. (Jennings, '96). Sandusky Bay, Lake Erie (Kellicott, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98). Pools about Hanover, N. H. (H. S. J.).

44. M. carinata Ehrenberg. (Plate 18, fig. 19.)

East Harbor, Lake Erie; swamp near fish-hatchery on South Bass Island; Portage River, Ohio.

Pond near Bangor, Me. (J. C. S., '83). Shiawassee River, at Corunna, Mich. (Kellicott, '88). Lake St. Clair and the following inland lakes of Michigan: West Twin Lake, Muskegon County; Crooked Lake, Newaygo County, and Chippewa Lake, Mecosta County (Jennings, '94). Lake Michigan, Round Lake, and Pine Lake, near Charlevoix, Mich. (Jennings, '96). Sandusky Bay, Lake Erie (Kellicott, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98). Common at Hanover, N. H. (H. S. J.).

45. M. elongata Gosse. (Plate 17, fig. 16.)

In *Utricularia* from Portage River, Ohio.

Sandusky Bay, Lake Erie (Kellicott, '97). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98). Pools, Hanover, N. H. (H. S. J.).

46. M. bicuspes Pell. (Plate 16, figs. 11 and 12.)

In *Utricularia* from East Harbor, Lake Erie.

This form has recently been redescribed by Stokes ('97) as *M. spinigera* n. sp. As the description and figure of Pell ('90) seem not well known, I give figures of dorsal and lateral views. Like *M. lata*, this species has five sensory projections on the corona, as shown in the figures.

Highland Falls, N. Y.? (Pell, '90, locality not stated). Trenton, N. J. (Stokes, '97, under name *M. spinigera* n. sp.).

47. M. mucosa Stokes. (Plate 17, fig. 18.)

One of the most abundant of the Rotifera among the vegetation of the shallow parts of Lake Erie about South Bass Island.

This is the two-keeled species mentioned without identification in my first paper on the Rotifera ('94), as being abundant in various lakes; it has since been described by Stokes under the above name. It differs from *M. bicristata* Gosse (fig. 17) in its shorter thicker body, and in the fact that the two keels extend only about one-half the length of the body. Lake St. Clair, Chippewa Lake, Mecosta County, Mich., and Crooked Lake, Newaygo County, Mich. (Jennings, '94, as "form with two large dorsal keels"). Round Lake and Old Channel, Charlevoix, Mich. (Jennings, '96, unnamed, p. 91). Trenton, N. J. (Stokes, '96*b*). Pond, Hanover, N. H. (H. S. J.).

M. bicristata Gosse. (Plate 17, fig. 17.) West Twin Lake near Charlevoix, Mich. (Jennings, '96); Sandusky Bay, Lake Erie (Kellicott, '97; possibly this was *M. mucosa* Stokes). Waters connected with the Illinois River near Havana, Ill. (Hempel, '98).

M. capucina Wierz. and Zach.—Lake St. Clair (Jennings, '94). West Twin Lake near Charlevoix, Mich. (Jennings, '96).

M. lata Jennings.—Lake St. Clair (Jennings '94). West Twin Lake near Charlevoix, Mich. (Jennings, '96). Sandusky Bay, Lake Erie (Kellicott, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98). This species has recently been found also by Steuroos ('98) in Finland.

M. rattus Ehr.—New York (Ehrenberg, '43). Near Minneapolis, Minn. (J. W., '83). Near Cincinnati, Ohio (Turner, '92). (Possibly the same thing was seen by Herrick ('85), who speaks of a rotifer resembling *Monocerca rattus.*) Sandusky Bay, Lake Erie (Kellicott, '97).

M. multicrinis Kellicott.—Sandusky Bay, Lake Erie (Kellicott, '97).

M. spinigera Stokes = *M. bicuspes* Pell.

RATTULUS Ehrenberg.

48. R. tigris Müller. (Plate 18, figs. 20 and 21.)

In *Naias*, Put-in Bay Harbor, Lake Erie.

The animal described and figured by Gosse in the Monograph under the above name is apparently not Ehrenberg's species at all; my specimens seem to agree with those of Ehrenberg. Characteristic seems to be the curved body, not enlarged in front as is figured by Gosse, but tapering gradually from about the middle to the foot; also the single large tooth at the anterior margin of the lorica. The anterior part of the lorica has about nine longitudinal folds, extending from the anterior margin to the constriction separating that part of the lorica covering the head from that covering the body. At the base of each of the two main toes are four minute substyles (fig. 21).

Pond near Bangor, Me. (J. C. S., '83). Turner ('92) records "*Rattulus tigris*" from the neighborhood of Cincinnati, Ohio, citing *Rattulus tigris* of Hudson and Gosse and *Diurella tigris* of Herrick ('85) for accounts of the animal. Now, these two latter represent two entirely different animals, Herrick's animal being *Cœlopus porcellus*, while, as noted above, the *Rattulus* described by Gosse is not the real *Rattulus tigris*. It is therefore impossible to say what the animal observed by Turner was.

49. R. sulcatus Jennings.

Not uncommon in shallow parts of Lake Erie about South Bass Island.

Lake St. Clair (Jennings, '94). Old Channel and West Twin Lake near Charlevoix, Mich. (Jennings, '96). Sandusky Bay, Lake Erie (Kellicott, '96).

R. palpitatus Stokes (= *Cœlopus brachyurus* Gosse?).—Trenton, N. J. (Stokes, '96*b*).

"*Diurella tigris* Bory," Herrick ('85) = *Cœlopus porcellus* Gosse.

Diurella insignis Herrick ('85). See *Cœlopus tenuior*.

CŒLOPUS Gosse.

As has been several times pointed out of late, this is a genus which was founded on an incorrect interpretation of the structure of the toes. When the Rattulidæ are subjected to the revision which they so much need, probably the name *Cœlopus* will disappear; until that is done it will be best to retain the names commonly used.

50. C. porcellus Gosse. (Plate 18, figs. 22 and 23.)

Not uncommon in the vegetation of shallow parts of Lake Erie about South Bass Island.

Ohio and Minnesota (Herrick, '85, under the name *Diurella tigris* Bory). Shiawassee River at Corunna, Mich. (Kellicott, '88). Lake St. Clair, Crooked Lake, Newaygo County, Mich. (Jennings, '94). Old Channel, Charlevoix, Mich. (Jennings, '96). Sandusky Bay, Lake Erie (Kellicott, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98). Pools, Hanover, N. H. (H. S. J.).

51. C. brachyurus Gosse. (Plate 18, fig. 24.)

East Harbor, Lake Erie; swamp near fish-hatchery on South Bass Island.

Shiawassee River at Corunna, Mich. (Kellicott, '88). Pools, Hanover, N. H. (H. S. J.).

C. tenuior Gosse. Doubtfully reported by Kellicott ('88) from the Shiawassee River at Corunna, Mich. Old Channel, Charlevoix, Mich. (Jennings '96). Sandusky Bay, Lake Erie (Kellicott, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel '98). *Diurella insignis* Herrick ('85) apparently should be referred to this species. Weber ('98) refers it to *Cœlopus porcellus*, yet an inspection of Herrick's figure shows that the proportions are totally different from those of the latter species, while they agree fairly well with those of *C. tenuior;* moreover, Herrick had already described *C. porcellus* on the preceding page of his paper, under the name *Diurella tigris*. *Diurella insignis* (*C. tenuior*) was found in Minnesota.

Heterognathus notommata Schmarda (= *Cœlopus tenuior?*). Brackish water near New Orleans (Schmarda, '59).

Family 12. DINOCHARIDÆ.

DINOCHARIS Ehrenberg.

52. D. pocillum Ehrenberg.

East Harbor, Lake Erie, in bottom vegetation.

Minneapolis, Minn. (J. W., '83). Pond near Bangor, Me. (J. C. S., '83). Minnesota (Herrick, '85). Shiawassee River, at Corunna, Mich. (Kellicott, '88). Lake St. Clair and the following inland lakes of Michigan: McLaren Lake, Oceana County; Crooked Lake, Newaygo County; Chippewa Lake, Mecosta County (Jennings, '94). Round Lake, Charlevoix, Mich. (Jennings, '96). Sandusky Bay, Lake Erie (Kellicott, '97). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

53. D. tetractis Ehrenberg.

Bottom vegetation of Put-in Bay Harbor and East Harbor, Lake Erie; more numerous than the last. Herrick ('85, p. 52) mentions as occurring in Minnesota a species of *Dinocharis* resembling *D. pocillum*, but lacking the spine on last joint of the foot; this was evidently *D. tetractis*. Shiawassee River, at Corunna, Mich. (Kellicott, '88). Lake St. Clair and the following inland lakes of Michigan: Crooked Lake, Newaygo County; Chippewa Lake, Mecosta County (Jennings, '94). West Twin Lake, and pool on the shore of Pine Lake, near Charlevoix, Mich. (Jennings, '96). Hanover, N. H. (H. S. J.).

POLYCHÆTUS Perty.

54. P. subquadratus Perty.

Bottom vegetation, Put-in Bay Harbor and East Harbor, Lake Erie.

Lake St. Clair (Jennings, '94). Old Channel, Charlevoix, Mich. (Jennings, '96). Sandusky Bay, Lake Erie (Kellicott, '97).

55. P. collinsii Gosse.

In *Myriophyllum* from East Harbor, Lake Erie; in *Utricularia* from Portage River, Ohio, not far from the mouth.

Pools and Old Channel, Charlevoix, Mich. (Jennings, '96).

P. serica Thorpe.—Sandusky Bay, Lake Erie (Kellicott, '97).

SCARIDIUM Ehrenberg.

56. S. longicaudatum Ehrenberg.

Very abundant in shallow parts of Lake Erie about South Bass Island and in East Harbor.

Shiawassee River, at Corunna, Mich. (Kellicott, '88). Near Cincinnati, Ohio (Turner, '92). Lake St. Clair and the following inland lakes of Michigan: McLaren Lake, Oceana County; Crooked Lake, Newaygo County; Chippewa Lake, Mecosta County (Jennings, '94). Pine Lake and Old Channel, Charlevoix, Mich. (Jennings, '96). Sandusky Bay, Lake Erie (Kellicott, '96). Trenton, N. J. (?) (Stokes, '96*a*). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

S. eudactylotum Gosse.—This animal is represented in fig. 1, plate IV, of Herrick, '85, under the title "undetermined." It was thus evidently found by Herrick somewhere in America; no locality is given. Chippewa Lake, Mecosta County, Mich. (Jennings, '94).

Stephanops muticus Ehrenberg.—Said by Herrick ('85) to occur somewhere in America. Lake St. Clair; Chippewa Lake, Mecosta County, Mich. (Jennings, '94). Sandusky Bay, Lake Erie (Kellicott, '97).

S. lamellaris Ehrenberg.—Minneapolis, Minn. (J. W. '83). Shiawassee River, at Corunna, Mich. (Kellicott, '88). Sandusky Bay, Lake Erie (Kellicott, '96).

S. chlæna Gosse.—Sandusky Bay, Lake Erie (Kellicott, '96).

Family 13. SALPINADÆ.

DIASCHIZA Gosse.

57. D. semiaperta Gosse.

Abundant in bottom vegetation of Put-in Bay Harbor and East Harbor, Lake Erie.

Lake St. Clair (Jennings, '94). Round Lake and pools, Charlevoix, Mich. (Jennings, '96).

58. D. lacinulata Ehrenberg. (*Notommata lacinulata.*)

Common in vegetation of bottom of shallow parts of Lake Erie about South Bass Island.

Shiawassee River, at Corunna, Mich. (Kellicott, '88). Abundant in Michigan lakes (Jennings, '94).

Round Lake and West Twin Lake, Charlevoix, Mich. (Jennings, '96). Sandusky Bay, Lake Erie (Kellicott, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98). Pond, Hanover, N. H. (H. S. J.).

DIPLAX Gosse.

59. D. trigona Gosse.

Rather common at times in the swamp near the fish-hatchery on South Bass Island.

SALPINA Ehrenberg.

60. S. brevispina Ehrenberg.

Bottom vegetation, East Harbor, Lake Erie; swamp near fish-hatchery, South Bass Island.

Shiawassee River, at Corunna, Mich. (Kellicott, '88). Near Cincinnati, Ohio (Turner, '92). Lake St. Clair and the following inland lakes of Michigan: McLaren Lake, Oceana County; Crooked Lake, Newaygo County; Chippewa Lake, Mecosta County (Jennings, '94). Sandusky Bay, Lake Erie (Kellicott, '96).

61. S. macracantha Gosse.

In swamps on South Bass Island; in *Utricularia* from Portage River, Ohio.

S. ventralis Ehr.—Lake St. Clair; Chippewa Lake, Mecosta County, Mich. (Jennings, '94). Sandusky Bay, Lake Erie (Kellicott, '96).

S. mucronata Ehr.—Near Cincinnati, Ohio (Turner, '92).

S. eustala Gosse.—Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

S. macrocera Jennings.—Chippewa Lake, Mecosta County, Mich. (Jennings, '94).

S. similis Stokes (=*S. macracantha* Gosse?).—Trenton, N. J. (Stokes, '96*b*).

S. affinis Herrick (=*S. mucronata* Ehr.?).—Minneapolis, Minn. (Herrick, '85).

Family 14. EUCHLANIDÆ.

EUCHLANIS Ehrenberg.

62. E. dilatata Ehrenberg.

Very common in vegetation of the bottom of Put-in Bay Harbor and East Harbor, Lake Erie; also in swamps on South Bass Island, and from Portage River, Ohio.

Minnesota (Herrick, '85). Near Cincinnati, Ohio (Turner, '92). Lake St. Clair and the following inland lakes of Michigan: West Twin Lake, Muskegon County; White Lake, Muskegon County; Crooked Lake, Newaygo County; Chippewa Lake, Mecosta County (Jennings, '94). Sandusky Bay, Lake Erie (Kellicott, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

63. E. deflexa Gosse.

In bottom vegetation, Put-in Bay Harbor, Lake Erie.

Lake St. Clair and Chippewa Lake, Mecosta County, Mich. (Jennings, '94). Old Channel, Charlevoix, Mich. (Jennings, '96). Waters connected with Illinois River at Havana, Ill. (Hempel, '98).

64. E. pyriformis Gosse.

In *Elodea* from East Harbor, Lake Erie.

Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

65. E. triquetra Ehrenberg.

In bottom vegetation of Put-in Bay Harbor and East Harbor, Lake Erie.

Shiawassee River, at Corunna, Mich. (Kellicott, '88). Near Cincinnati, Ohio (Turner, '92). Lake St. Clair; McLaren Lake, Oceana County, Mich.; Chippewa Lake, Mecosta County, Mich. (Jennings, '94). Pool near Charlevoix, Mich. (Jennings, '96). Sandusky Bay, Lake Erie (Kellicott, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98). Brook, Hanover, N. H. (H. S. J.).

66. E. oropha Gosse.

Common in bottom vegetation of Put-in Bay Harbor and East Harbor, Lake Erie; also in swamps on South Bass Island and in pools on Starve Island.

Lake St. Clair (Jennings, '94). Round Lake and Old Channel, Charlevoix, Mich. (Jennings, '96). Pond, Hanover, N. H. (H. S. J.).

E. ampuliformis Herrick.—Minnesota (Herrick, '85).

E. parva Rousselet = *E. oropha* Gosse, according to Rousselet.

Family 15. CATHYPNADÆ.

Owing to the large number of species of this family, and the confusion and obscurity in regard to their determination, I have wherever possible introduced a figure of the species found in Lake Erie, in order that the animal may be identified without regard to considerations of nomenclature.

CATHYPNA Gosse.

67. C. luna Gosse. (Plate 19, figs. 28 and 29.)

Abundant in bottom vegetation of Lake Erie near the shore, in the region of South Bass Island.

Shiawassee River at Corunna, Mich. (Kellicott, '88). Lake St. Clair and the following inland lakes of Michigan: McLaren Lake, Oceana County; Crooked Lake, Newaygo County; Chippewa Lake, Mecosta County (Jennings, '94). Old Channel and West Twin Lake near Charlevoix, Mich. (Jennings, '96). Sandusky Bay, Lake Erie (Kellicott, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

68. C. leontina Turner. (Plate 19, fig. 25.)

In *Chara* from East Harbor, Lake Erie, and East Swamp, South Bass Island.

This species was recently redescribed by Stokes ('97) as *C. scutaria* and by Daday ('98) as *C. macrodactyla*. The identification of *C. leontina* Turner with *Distyla icthyoura* Anderson and Shephard ('92) (*Cathypna appendiculata* Levander, '94), as proposed by Rousselet ('97, p. 12) and Stenroos ('98, p. 162), seems to me impossible. I believe that a comparison of fig. 25 of *C. leontina* with the figures given by the above-named authors makes this at once evident. *Cathypna leontina* is broad and short (a true *Cathypna*), with immensely long, slender toes, and with the lorica ending in a short plate which projects backward at the angles into two large points with a concavity between them. *Distyla icthyoura*, on the other hand, is slender (a true *Distyla*), the toes are short, and the posterior projection of the lorica is much broader at the distal end and is there squarely truncate.

Near Cincinnati, Ohio (Turner, '92). Lake St. Clair (Jennings, '94). Sandusky Bay, Lake Erie (Kellicott, '97). Trenton, N. J. (Stokes, '97, under the name *C. scutaria*). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

69. C. ungulata Gosse. (Plate 19, figs. 26 and 27.)

Common among aquatic plants of East Harbor, Lake Erie, and Portage River, Ohio; also in East Swamp, South Bass Island.

This is the largest of the Cathypnadæ, measuring 310μ in length, including the toes. It is one of the commonest of the Rotifera in the Great Lakes. This species has recently been redescribed by Stokes ('97) as *C. glandulosa* n. sp., and by Stenroos ('98) as *C. magna* n. sp. The variety *tenuior* of Stenroos was common in Lake Erie among the type specimens.

Minnesota (figured by Herrick, '84, plate v, fig. 5, without a name). Lake St. Clair (Jennings, '94). Trenton, N. J. (Stokes, '97, under the name *C. glandulosa* n. sp.).

C. scutaria Stokes ('97) = *C. leontina* Turner.

C. glandulosa Stokes ('97) = *C. ungulata* Gosse.

DISTYLA Eckstein.

70. D. ohioensis Herrick ('85). (Plate 20, fig. 30.)

East Harbor, Lake Erie, and East Swamp, South Bass Island.

This species resembles in many respects *D. icthyoura* Anderson and Shephard ('92), (*Cathypna appendiculata* Levander, '94). But it differs from that in the fact that the posterior projection of the lorica is not broader at the end, so as to make it "fish-tailed," and in the presence of the facets on the dorsal surface. Herrick's description and figure of *D. ohioensis* are exceedingly poor, yet his account differs from those of the above-named authors in exactly the points just mentioned. Herrick's name is therefore accepted for this species. All distinctive features are shown in the figure.

Ohio (Herrick, '85). Near Cincinnati, Ohio (Turner, '92). Lake St. Clair and Crooked Lake, Newaygo County, Mich. (Jennings, '94). Sandusky Bay, Lake Erie (Kellicott, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

71. D. gissensis Eckstein ('83). (Plate 20, figs. 33 and 34.)

Swamp near fish-hatchery on South Bass Island.

Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

72. D. ludwigii Eckstein ('83). (Plate 20, fig. 32.)

On aquatic plants in Put-in Bay Harbor, Lake Erie.

The specimens found agree precisely with *D. oxycauda* as described by Stenroos ('98). This author holds that the differences between the specimens found by him and Eckstein's figure of *D. ludwigii* are sufficient to justify describing them as a new species. These differences concern chiefly the form and distribution of the facets on the dorsal surface, and the shape of the toes. But Eckstein's figure certainly gives the impression of trying to represent the facets only in a most general way, without attention to detail; and as for the toes, a study of Eckstein's other figures, of known forms, shows that he made little attempt to be precise in his representation of such external characters. I therefore agree with Weber ('98) in considering *D. oxycauda* a synonym of *D. ludwigii.*

Lake St. Clair (Jennings, '94).

73. D. stokesii Pell. (Plate 20, fig. 31.)

On aquatic plants in Put-in Bay Harbor, Lake Erie.

Pell ('90) describes this form without giving the locality where found; it was probably at Highland Falls, N. Y. Lake St. Clair and Chippewa Lake, Mecosta County, Mich. (Jennings, '94). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

74. D. flexilis Gosse.

In *Characeæ* from Put-in Bay Harbor, Lake Erie, and from East Swamp, South Bass Island.

D. signifera Jennings.—West Twin Lake near Charlevoix, Mich. (Jennings, '96).

D. inermis Bryce.—Sphagnum swamp near Pine Lake, Charlevoix, Mich. (Jennings, '96).

D. spinigera Western.—Sandusky Bay, Lake Erie (Kellicott, '97).

D. hornemanni Ehr.—Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

D. minnesotensis Herrick.—This is an unrecognizable species; it is said by Herrick ('85) to occur "in America,"—from the name, doubtless in Minnesota.

MONOSTYLA Ehr.

The species of this genus have fallen into confusion that seems almost inextricable; the genus is in great need of a critical revision from a single standpoint. Four species of *Monostyla* are very common almost everywhere, and the same four species are to be found frequently described and figured in the literature of the subject. Four specific names are usually distributed among these species—*M. quadridentata* Ehr., *M. lunaris* Ehr., *M. cornuta* Ehr., and *M. bulla* Gosse—but the names and figures are joined together in the most varied ways. I give herewith figures of these four species (figs. 35 to 41) and will attempt by analysis of previous accounts to show the proper name to be applied to each.

The name *Monostyla quadridentata* Ehr. unquestionably belongs to the form shown in fig. 40, plate 21. This species is so strongly marked by the two great spines at the anterior margin of the lorica that confusion with any other species is almost impossible.

As to *M. lunaris* there is much confusion in the literature. Hudson and Gosse ('89) figure under this name the rotifer, a ventral view of which is shown in my fig. 41, plate 21. It is possible also that the *M. lunaris* figured by Levander ('94) is the same, though he represents the animal as having two claws at the end of the toe.

Eckstein ('83) and Weber ('98) figure under this name an entirely different animal—that shown in my figs. 37, 38, and 39, plate 21.

Referring to the original description of *M. lunaris* by Ehrenberg ('38), we find that the chief distinctive feature of this species is the lunate concavity at the front of the lorica—"fronte lunatim excisa." This character gives the specific name *lunaris*, and Ehrenberg's figures show a broad crescentic inward curve from one lateral angle to the other at the wide front edge of the lorica when the animal is retracted. This shows that the animal called *M. lunaris* by Eckstein ('83) and Weber ('98) can not possibly be that species, as it lacks precisely the distinctive feature that gives the name to the species—namely, the crescent-shaped concavity at the front edge of the lorica. No matter how much contracted, this animal never shows a crescentic curve at the anterior margin; the actual contours at the anterior end in retraction are shown in my fig. 39. On the other hand, the animal called *M. lunaris* by Gosse (and Levander?) has this crescentic curve as the anterior margin of the lorica; hence I accept their determination as correct. This same animal (fig. 41) seems to be that figured by Eckstein ('83) as *M. cornuta.*

In regard to *M. cornuta* Ehr., its distinctive features, according to Ehrenberg ('38), are the oval form of the lorica, *not* deeply excised in front. Ehrenberg mentions also its remarkable resemblance to *Cathypna luna*, almost the only difference between the two animals being the presence of two toes

in the latter. An animal fulfilling precisely these requirements is very abundant, and is shown in figs. 35 and 36, plate 20. This seems unquestionably the animal figured under the name *M. cornuta* by Hudson and Gosse; by Levander ('94); by Bryce ('91), and by Ehrenberg himself ('38). The animal figured as *M. cornuta* by Eckstein ('83) is too broad and deeply excised at the anterior margin for this species; it seems more likely to have been *M. lunaris* Ehr.

For *M. bulla*, Gosse's specific characters are as follows: "Lorica a pointed oval; dorsal and ventral plates both gibbous and nearly coequal; toe rod-shaped in vertical aspect, with a two-shouldered claw, but decurved and tapering gradually in lateral aspect." Further along in his description he says that the true distinctive characters are "The great rotundity of the ventral plate, the regular decurvation of the tapered toe, and the deep narrow sinus in both the occipital and the pectoral fronts of the lorica," his figure 4c showing that the sinus in the front of the ventral plate of the lorica ("pectoral front") is deeper than that in the dorsal plate. An animal fulfilling all these conditions and agreeing with Gosse's figures is one of the most abundant rotifers in America. It is shown in figs. 37, 38, and 39, plate 21. This is the species figured by Eckstein ('83) and Weber ('98) as *M. lunaris*. As already pointed out, the contours of the anterior margins of the lorical plates absolutely forbid that identification, while they as clearly point to *M. bulla* Gosse as the correct determination. The same animal is figured by Stokes ('96*b*) as *M. bipes* n. sp. Stokes bases his new name on the fact that there is a line running lengthwise in the middle of the small claw (a fact that had been noted or figured by various previous observers), and that he has seen the two halves of the claw spread apart at this line in dead specimens. Stenroos ('98) finally figures this animal correctly, as I believe, as *M. bulla* Gosse. The animal figured by Weber ('98) as *M. bulla* seems, to judge from Weber's figures, to have had almost none of the distinctive features of *M. bulla* Gosse.

I give the distribution of these four species in the following four numbers:

75. M. quadridentata Ehr. (Plate 21, fig. 40.)

Very abundant in the bottom and littoral vegetation of shallow parts of Lake Erie about South Bass Island and in the swamps on the island.

Minnesota (Herrick, '85). Near Cincinnati, Ohio (Turner, '92). Lake St. Clair and Crooked Lake, Newaygo County, Mich. (Jennings, '94). West Twin Lake, Charlevoix, Mich. (Jennings, '96). Sandusky Bay, Lake Erie (Kellicott, '96). Trenton, N. J. (Stokes, '96*a*). Waters connected with the Illinois River, at Havana, Ill. (Hempel, '98). Pond, Hanover, N. H. (H. S. J.).

76. M. lunaris Ehrenberg. (Plate 21, fig. 41.)

Synonym.—*M. cornuta* Eckstein ('83). (?)

Common in littoral and bottom vegetation of Lake Erie about South Bass Island and in the swamps on the island.

Shiawassee River at Corunna, Mich. (Kellicott, '88). Near Cincinnati, Ohio (Turner, '92). Lake St. Clair and the following inland lakes of Michigan: West Twin Lake, Muskegon County; McLaren Lake, Oceana County; Crooked Lake, Newaygo County; Chippewa Lake, Mecosta County (Jennings, '94). Round Lake and Old Channel, Charlevoix, Mich. (Jennings, '96). Sandusky Bay, Lake Erie (Kellicott, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

77. M. cornuta Ehrenberg. (Plate 20, figs. 35 and 36.)

In littoral and bottom vegetation of Lake Erie about South Bass Island and in the swamps on the island.

New York (Ehrenberg, '43). Shiawassee River at Corunna, Mich. (Kellicott, '88). Lake St. Clair; West Twin Lake, Muskegon County, Mich., and White Lake, Muskegon County, Mich. (Jennings, '94). Pool on shore of Pine Lake, near Charlevoix, Mich. (Jennings, '96). Waters connected with Illinois River at Havana, Ill. (Hempel, '98). Pond, Hanover, N. H.; Swamp near Norwich, Vt. (H. S. J.).

78. M. bulla Gosse. (Plate 21, figs. 37, 38, and 39.)

Synonyms—*M. lunaris*, Eckstein ('83), and Weber ('98). *M. bipes* Stokes ('96*b*).

One of the commonest rotifers among aquatic plants in parts of Lake Erie about South Bass Island and in the swamps on the island.

Shiawassee River at Corunna, Mich. (Kellicott, '88). Lake St. Clair and the following inland lakes of Michigan: McLaren Lake, Oceana County; Crooked Lake, Newaygo County; Chippewa Lake, Mecosta County (Jennings, '94). Old Channel and West Twin Lake, near Charlevoix, Mich. (Jennings, '96). Sandusky Bay, Lake Erie (Kellicott, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

79. M. closterocerca Schmarda.

Single specimen taken in towings in Lake Erie 2½ miles north of Kelley Island.

Lake St. Clair (Jennings, '94). Lake Michigan, Round Lake, and Pine Lake, near Charlevoix, Mich. (Jennings, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

80. M. hamata Stokes. (Plate 22, figs 42, 43, and 44.)

East Swamp, South Bass Island.

Trenton, N. J. (Stokes, '96*b*).

M. truncata Turner.—Near Cincinnati, Ohio (Turner, '92).

M. mollis Gosse.—Lake St. Clair (Jennings, '94). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

M. robusta Stokes.—Trenton, N. J. (Stokes, '96*b*).

M. ovata Forbes.—Warm spring on the shore of Yellowstone Lake, Yellowstone National Park (Forbes, '93).

M. bipes Stokes.—This is the same species as is recorded and figured above as *M. bulla*. Trenton, N. J. (Stokes, 96*b*).

Family 16. COLURIDÆ.

COLURUS Ehrenberg.

This is one of the genera which would repay a thorough study and revision.

81. C. bicuspidatus Ehrenberg.

On *Elodea* from East Harbor, Lake Erie.

Chippewa Lake, Mecosta County, Mich. (Jennings, '94). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

82. C. deflexus Ehrenberg.

In *Chara* from bottom of Put-in Bay Harbor, Lake Erie; in swamp near fish-hatchery on South Bass Island.

Sandusky Bay, Lake Erie (Kellicott, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

83. C. obtusus Gosse.

On aquatic plants in shallow parts of Lake Erie about South Bass Island.

Shiawassee River at Corunna, Mich. (Kellicott, '88). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

C. agilis Stokes.—Trenton, N. J. (Stokes, '96*c*).

C. caudatus Ehrenberg.—Shiawassee River at Corunna, Mich. (Kellicott, '88).

METOPIDIA Ehrenberg.

84. M. lepadella Ehrenberg.

Abundant in vegetation of shallow and swampy parts of Lake Erie about South Bass Island and in the swamps on the island.

The species to which I have applied the above name is abundant everywhere and is very variable, so as to give much opportunity for the creation of new species, an opportunity which has been fully utilized. A thorough revision of the species of *Metopidia* would be of much value to the systematist, besides doubtless furnishing an interesting study in the field of variation.

Shiawassee River at Corunna, Mich. (Kellicott, '88). Lake St. Clair and McLaren Lake, Oceana County, Mich. (Jennings, '94). Pool on the shore of Pine Lake; Old Channel, Charlevoix, Mich. (Jennings, '96). Sandusky Bay, Lake Erie (Kellicott, '96). Pools, Hanover, N. H. (H. S. J.).

85. M. acuminata Ehrenberg.

Common in aquatic plants from bottom of Put-in Bay Harbor, Lake Erie.

Pond near Bangor, Me., (J. C. S., '83). Lake St. Clair; Crooked Lake. Newaygo County, Mich.; Chippewa L., Mecosta County, Mich. (Jennings, '94). Round Lake, Charlevoix, Mich. (Jennings, '96). Waters connected with Illinois River at Havana, Ill. (Hempel, '98). Pool near Norwich, Vt. (H. S. J.).

86. M. rhomboides Gosse.

In *Characeæ* from Put-in Bay Harbor and East Harbor, Lake Erie, and from swamps on South Bass Island.

Chippewa Lake, Mecosta County, Mich. (Jennings, '94). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

87. M. solidus Gosse.

East Swamp, South Bass Island.

Sphagnum Swamp near Pine Lake, Mich. (Jennings, '96). Sandusky Bay, Lake Erie (Kellicott, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

88. M. triptera Ehrenberg.

In *Chara* from East Harbor, Lake Erie.

Shiawassee River at Corunna, Mich. (Kellicott, '88). Lake St. Clair, and the following inland lakes of Michigan: McLaren Lake, Oceana County; Crooked Lake, Newaygo County (Jennings, '94). Swamp on shore of Pine Lake, Charlevoix, Mich. (Jennings, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98). Pool near Norwich, Vermont (H. S. J.).

89. M. ehrenbergii Perty. (*Notogonia ehrenbergii* Perty.)

In *Myriophyllum* from East Harbor, Lake Erie; in swamp near fish-hatchery on South Bass Island.

Lake St. Clair and the following inland lakes of Michigan: McLaren Lake, Oceana County; Crooked Lake, Newaygo County; Chippewa Lake, Mecosta County (Jennings, '94). Pool on shore of Pine Lake; West Twin Lake; Old Channel at Charlevoix, Mich. (Jennings, '96). Sandusky Bay, Lake Erie (Kellicott, '97).

90. M. salpina Ehrenberg. (*M. oxysternum* Gosse.)

Swamp near fish-hatchery on South Bass Island.

As Bilfinger ('94) has shown, Gosse's *M. oxysternum* is the same as Ehrenberg's *Lepadella? salpina*, so that there seems no sufficient reason for using Gosse's specific name any longer.

Sandusky Bay, Lake Erie (Kellicott, '96, as *M. oxysternum*). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98, as *M. oxysternum*).

M. oblonga Ehrenberg.—Near Cincinnati, Ohio (Turner, '92, as *M. elliptica* n. sp.). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98). Ditch at Hanover, N. H. (H. S. J.).

M. dentata Turner.—Near Cincinnati, Ohio (Turner, '92).

M. bractea Ehrenberg.—Minnesota (Herrick, '85; identification uncertain). Near Cincinnati, Ohio (Turner, '92). Lake St. Clair, and McLaren Lake, Oceana County, Mich. (Jennings, '94). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

M. collaris Stokes.—Trenton, N. J. (Stokes, '96*b*).

M. collaris var. *similis* Stokes.—Trenton, N. J. (Stokes, '96*b*).

M. (Lepadella) cornuta Schmarda.—Brackish water near New Orleans (Schmarda, '59).

M. elliptica Turner = *M. oblonga* Ehr.

Cochleare turbo Gosse.—Lake St. Clair; also Crooked Lake, Newyago County, Mich., and Chippewa Lake, Mecosta County, Mich. (Jennings, '94).

Family 17. PTERODINADÆ.

PTERODINA Ehrenberg.

91. P. patina Ehrenberg.

Common in aquatic vegetation of Put-in Bay Harbor and East Harbor, Lake Erie; also from Portage River, Ohio.

Herrick ('85) figures this species, but does not give the locality where found. Niagara River (Kellicott, '87). Shiawassee River at Corunna, Mich. (Kellicott, '88). Near Cincinnati (Turner, '92). Lake St. Clair, and the following inland lakes of Michigan: McLaren Lake, Oceana County; Crooked Lake, Newaygo County; Chippewa Lake, Mecosta County (Jennings, '94). Pool on the shore of Pine Lake and West Twin Lake near Charlevoix, Mich. (Jennings, '96). Sandusky Bay, Lake Erie (Kellicott, '96). Trenton, N. J. ? (Stokes, '96*a*). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

92. P. reflexa Gosse.

In aquatic vegetation from East Harbor, Lake Erie.

Lake St. Clair, and the following inland lakes of Michigan: McLaren Lake, Oceana County; Crooked Lake, Newaygo County; Chippewa Lake, Mecosta County (Jennings, '94). Pine Lake and West Twin Lake near Charlevoix, Mich. (Jennings, '96). Sandusky Bay, Lake Erie (Kellicott, '96).

P. bidentata Ternetz.—Lake St. Clair (Jennings, '94).

P. parva Ternetz.—West Twin Lake, near Charlevoix, Mich. (Jennings, '96).

P. valvata Hudson.—Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

Family 18. BRACHIONIDÆ.

BRACHIONUS Ehr.

93. B. bakeri Ehrenberg. (Plate 22, figs. 45 and 46.)

One of the commonest rotifers in East Harbor, Lake Erie, and in the swamps on South Bass Island. The animal varies exceedingly in the form of the lorica and in the development of the spines on the lorica. In small land-locked pools in the glacial markings on Starve Island, a form with very short spines (fig. 45) was abundant; in the swamps of South Bass Island the long-spined variety (fig. 46) was found. The pools on Starve Island are subject to evaporation and frequent drying up by the sun; possibly the different form found in these pools is due to the greater concentration of various salts in this water or to some kindred factor. *B. bakeri* is known to vary excessively (see Rousselet, '97*b*, for figures of the chief variations); it would probably be a favorable form for an experimental study of the causes of variation. It seems hardy, and can usually be procured in quantity, so that it could probably be cultivated under experimental conditions.

Granville, Ohio (Herrick, '85). Shiawassee River at Corunna, Mich. (Kellicott, '88). Near Cincinnati, Ohio (Turner, '92). Lake St. Clair and Chippewa Lake, Mecosta County, Mich. (Jennings, '94). Pool on shore of Pine Lake, and in West Twin Lake, near Charlevoix, Mich. (Jennings, '96). Trenton, N. J. (Stokes, '96*a*). Waters connected with Illinois River at Havana, Ill. (Hempel, '98).

B. bakeri var. *brevispinus*. Waters connected with Illinois River at Havana, Ill. (Hempel, '98).

94. B. militaris Ehrenberg.

Very abundant in swampy parts of Lake Erie, in Portage River, Ohio, and in the swamps on South Bass Island.

In Hemlock Lake, near Rochester, N. Y. (Attwood, '81, under the name *B. conium*). Croton water, the New York water supply (Hitchcock, '81, under the name *B. conium* Attwood). Minnesota (Herrick, '84, plate v, fig. 6, not named). "Common in the West" (Herrick, '85). Creek on Grand Island and in Buffalo City Park (Kellicott, '87, under the name *B. conium* Attwood). Shiawassee River at Corunna, Mich. (Kellicott, '88, under the name *Noteus conium* Attwood). Near Cincinnati, Ohio (Turner, '92). Lake St. Clair (Jennings, '94). Susan Lake and West Twin Lake, in north Michigan (Jennings, '96). Sandusky Bay, Lake Erie (Kellicott, '96). Water connected with the Illinois River at Havana, Ill. (Hempel, '98).

B. pala Ehrenberg.—Near Minneapolis, Minn. (J. W., '83). Near Cincinnati, Ohio (Turner, '92). Sandusky Bay, Lake Erie (Kellicott, '97). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

B. urceolaris Ehrenberg.—Near Cincinnati, Ohio (Turner, '92). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

B. tuberculus Turner.—Near Cincinnati, Ohio (Turner, '92). Sandusky Bay, Lake Erie; also found by C. C. Mellor at Newark, Ohio (Kellicott '97).

B. mollis Hempel.—Waters connected with the Illinois River at Havana, Ill. (Hempel, '96 and '98).

B. dorcas Gosse.—Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

B. dorcas var. *spinosus* Wierz.—With the type (Hempel, '98).

B. punctatus Hempel.—Waters connected with the Illinois River at Havana, Ill. (Hempel, '96 and '98).

B. rubens Ehrenberg.—Shiawassee River at Corunna, Mich. (Kellicott, '88). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

B. variabilis Hempel.—Waters connected with the Illinois River at Havana, Ill. (Hempel, '96 and '98).

B. angularis Gosse.—Sandusky Bay, Lake Erie (Kellicott, '97). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

B. angularis var. *bidens* Plate.—Waters connected with Illinois R. at Havana, Ill. (Hempel, '98).

B. gleasoni Up de Graff.—Elmira, N. Y. (Up de Graff, '82 and '83).

B. conium Attwood = *B. militaris* Ehr.

B. intermedius Herrick ('85).—Insufficiently described for recognition. It seems probable from the points mentioned that the animal was *Noteus quadricornis* Ehr. Locality not given.

Schizocerca diversicornis Daday.—Waters connected with Illinois R. at Havana, Ill. (Hempel, '98).

S. diversicornis var. *homoceros* Wierz.—With the type (Hempel, '98).

NOTEUS Ehr.

95. N. quadricornis Ehrenberg.

East Swamp, South Bass Island.

Near Minneapolis, Minn. (J. W., '83). Shiawassee River at Corunna, Mich. (Kellicott, '88). Lake St. Clair and Chippewa Lake, Mecosta County, Mich. (Jennings, '94). Pool on the shore of Pine Lake near Charlevoix, Mich. (Jennings, '96). Sandusky Bay, Lake Erie (Kellicott, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98). Ditches, Hanover, N. H. (H. S. J.).

Noteus conium Attwood = *Brachionus militaris*.

Family 19. ANURÆADÆ.

ANURÆA Gosse.

96. A. cochlearis Gosse.

Abundant in towings from Lake Erie in the region about South Bass Island.

Lake Erie (Vorce, '81; figured (fig. 181) but not named). Near Cincinnati, Ohio (Turner, '92). Water from Lake Michigan at Chicago (Jelliffe, '93). Lake St. Clair and the following inland lakes of Michigan: McLaren Lake, Occana County; Crooked Lake, Newaygo County; Chippewa Lake, Mecosta County (Jennings, '94). Lake Michigan, Round Lake, Pine Lake, West Twin Lake, and Susan Lake, in north Michigan (Jennings, '96). Sandusky Bay, Lake Erie (Kellicott, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

A. cochlearis var. *tecta* Gosse.—Near Cincinnati, Ohio (Turner, '92). Sandusky Bay, Lake Erie (Kellicott, '97). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

A. aculeata Ehr.—Lake St. Clair and in Whitmore Lake, Washtenaw County, Mich. (Jennings, '94). Lake Michigan, near Charlevoix, Mich. (Jennings, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

A. aculeata var. *valga* Ehr.—Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

A. serrulata Ehr.—This is figured by Herrick ('85) as "*Anuræa* sp.," and is said by him to be "very common in the West." Lake St. Clair (Jennings, '94). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

A. hypelasma Gosse.—Waters connected with the Illinois River at Havana, Ill. (Hempel, '98). Pond at Hanover, N. H. (H. S. J.).

A. stipitata Ehr.—New York (Ehrenberg, '43). Lake Erie (Vorce, '81, and Kellicott, '96). Niagara River (Mills, '82).

NOTHOLCA Gosse.

97. N. longispina Kellicott.

In towings from Put-in Bay Harbor, Lake Erie; few.

Niagara River (Kellicott, '79, and Mills, '82). Lake Erie (Vorce, '81). Lake Mendota, Wisconsin (Forbes, '90). Lake St. Clair and Chippewa Lake, Mecosta County, Mich. (Jennings, '94). Lake Michigan, Round Lake, and Pine Lake, near Charlevoix, Mich. (Jennings, '96). Sandusky Bay, Lake Erie (Kellicott, '97). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

N. scapha Gosse.—Lake Michigan and Round Lake, near Charlevoix, Mich. (Jennings, '96).

N. foliacea Ehrenberg.—Round Lake, Charlevoix, Mich. (Jennings, '96).

N. acuminata Ehr.—New York (Ehrenberg, '43, identification doubtful). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98). Huron River at Ann Arbor, Mich. (H. S. J.).

N. labis Gosse.—Huron River at Ann Arbor, Mich. (H. S. J.).

N. striata Ehrenberg.—Lake Michigan, near Chicago (Forbes, '83, p. 106).

Family 20. PLŒSOMADÆ.

Following the example of Weber ('98), I place together, at the end of the Loricata, the three families Plœsomadæ, Gastropodidæ, and Anapodidæ, comprising loricate Rotifera that have been described for the most part since the publication of Hudson and Gosse's Monograph. In a former list ('94) I placed *Plœsoma* and *Gastropus* in the Hydatinadæ, while *Anapus* was given a place next to *Ascomorpha;* all three genera thus among the Illoricata. I still believe such an arrangement expresses more nearly the relationship of the animals; that the separation of the Rotifera into two great groups, according as the cuticula is or is not stiffened to form a lorica, is an artificial classification, often widely separating species that are really closely related. But since I am, from motives of convenience, using in this list Hudson and Gosse's classification, it will be more logical to place these three loricated groups among the Loricata; this will not separate closely related species any more widely than is done by this classification in many other parts of the system.

PLŒSOMA Herrick.

98. P. lenticulare Herrick.

From aquatic plants in Put-in Bay Harbor, Lake Erie; also in towings from the open lake.

The synonymy of this species is much confused and has led to a great deal of discussion; an excellent summary of this is given by Hood ('95). In a note in the *Zoologischer Anzeiger* of 1894 I pointed out that the generic name *Plœsoma*, due to Herrick ('85), has the priority for this genus, and this has been generally accepted, except by Scandinavian investigators, who cling to the name *Gastroschiza*, proposed by a Scandinavian, without regard to the laws of priority. In that note I considered it probable that this species is the *Euchlanis* (?) *lynceus* of Ehrenberg, and in accordance with that view I have used the name *P. lynceus* in my papers of 1894 and 1896. The note above referred to concludes, however: "If it be held that this is not the *Euchlanis lynceus* of Ehrenberg, then Herrick's name, *Plœsoma lenticulare*, has the priority." In view of recent studies on the genus by various authors this conditional statement must be held to represent the more probable view, so that the name *P. lenticulare* should be used for this species.

Weber has recently founded the family Plœsomadæ for this and related rotifers, placing the family among the Loricata. In my previous papers I have followed Wierzejski ('93) in placing this genus in close proximity to the genus *Notops* (as formerly constituted), among the Hydatinadæ. This disposition of the genus has repeatedly been credited to me (Hood, '95; Weber, '98, p. 737). While I believe that its relationship is much better expressed in this way than by transferring it to the purely artificial group Loricata, I must disclaim having originated this view.

Lake Erie (Vorce, '82, as "remarkable rotifer, undescribed"; Vorce, '87, as *Gomphogaster areolatus* Vorce; Kellicott, '96). Reservoir near Hebron, Ohio (Herrick, '85). Lake St. Clair; Crooked Lake, Newaygo County, Mich.; Chippewa Lake, Mecosta County, Mich. (Jennings, '94, as *P. lynceus* Ehr.). Lake Michigan, Round Lake, Pine Lake, West Twin Lake, and Susan Lake, all in north Michigan (Jennings, '96, as *P. lynceus* Ehr.). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98, under name *P. lynceus* Ehr.).

P. hudsoni Imhof.—Lake St. Clair (Jennings, '94). Lake Michigan and Round Lake, near Charlevoix, Mich. (Jennings, '96).

P. truncatum Levander.—Among the specimens of *P. lenticulare* found in Lake St. Clair in 1893 were numbers of a smaller form, with a more wrinkled, less angular lorica. Notes were made at the time, but thinking it might possibly be a young form of *P. lenticulare*, I did not describe it. It has since been described as a new species, *P. truncatum*, by Levander; this must, then, be added to the list of species inhabiting Lake St. Clair. It has since been found by Kellicott ('97) in Sandusky Bay, Lake Erie.

P. molle Kellicott.—Sandusky Bay, Lake Erie (Kellicott, '97).

Family 21. GASTROPODIDÆ.

GASTROPUS Imhof ('88).

Weber ('98) has revived this name for the animal which has been called *Hudsonella picta* and *Notops pygmæus*. The name *Gastropus*, published in 1888, undoubtedly has the priority as a name for this distinct genus unless it be held that Imhof's description is insufficient for a recognition of the animal described. The description is undoubtedly meager, and most investigators have since been inclined to disregard the name as insufficiently founded; on that account I also have in previous papers used another name. But one investigator in good standing is in a position to force others to use a name which unquestionably has priority, when he maintains that he is able to recognize the species, one positive instance being worth more than many negative ones. Weber ('98) takes this position in regard to *Gastropus*, so that I believe it best to accept the name which he uses as inevitable, without further ado. Moreover, in my opinion, Imhof's *Gastropus stylifer* is, as a matter of fact, plainly recognizable, and I used this name for the animal in question as far back as in my paper of '94*b*, dropping it only when opinion seemed unanimous against this view. To the same genus are to be referred *Notops hyptopus* Ehr., *Notops minor* Rousselet, *Notops fennicus* Stenroos, and *Hypopus ritenbenkii* Bergendal.

99. G. stylifer Imhof ('88). (*Notops pygmæus* Calman; *Hudsonella picta* Zacharias.)

A single specimen in towings from Put-in Bay Harbor, Lake Erie.

Lake St. Clair and Whitmore Lake, Washtenaw County, Mich. (Jennings, '94, under the name *Notops pygmæus* Calman). Round Lake, Pine Lake, Lake Michigan, and West Twin Lake, near Charlevoix, Mich. (Jennings, '96, as *Notops pygmæus* Calman).

G. minor Rousselet.—Sandusky Bay, Lake Erie (Kellicott, '97, as *Notops minor*).

Family 22. ANAPODIDÆ.

ANAPUS Bergendal.

100. **A. ovalis** Bergendal.

One specimen, from surface towing in Lake Erie, taken 2½ miles north of Kelley Island.

Lake St. Clair (Jennings, '94); Lake Michigan, Round Lake, and West Twin Lake near Charlevoix, Mich. (Jennings, '96).

Family 23. PEDALIONIDÆ.

Pedalion mirum Hudson.—Sandusky Bay, Lake Erie (Kellicott, '97). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

SUMMARY.

The foregoing list shows that (excluding varieties, synonyms, and doubtfully identified animals) 246 species have been recorded as occurring in the United States. These are distributed by States, as follows: Michigan 160, Ohio 155, Illinois 112, New Jersey 29, New Hampshire 23, New York 21, Maine 18, Minnesota 18, Pennsylvania 13, Vermont 6, Yellowstone Park 4, Louisiana 2 (?), North Carolina 2 (?), Virginia 1, Wisconsin 1, California 1.

It will be understood of course that the fact that large numbers are recorded from certain States, while in others few or no rotifers have been observed, is due purely to unequal distribution of investigators. It is probable that at least as many species of Rotifera as are included in the entire list might by careful investigation be found in any State in the Union.

The only large bodies of water that have been investigated with any degree of completeness are Lake St. Clair, Lake Erie, and the Illinois River. In the Great Lakes there have been found altogether 164 rotifers. Lake Erie has 132 species, Lake St. Clair 111 species, Lake Michigan 25 species. From the other Great Lakes no rotifers have been recorded. From the Illinois River 105 species and 5 varieties have been recorded; 74 of these are common to the Illinois River and the Great Lakes; 25 are found in the Illinois River and not in the Great Lakes; 90 in the lakes and not in the Illinois River. 57 species have been found neither in the Great Lakes nor in the Illinois River, but in small ponds, pools, streams, and swamps in various parts of the United States.

The fauna of the Illinois River is characterized, as compared with that of the Great Lakes, by a greater proportion of species living in swampy regions. The 25 species which are recorded from that stream and which have not been found in the Great Lakes include, for example, 3 species of *Asplanchna* and 7 Brachionidæ, characteristic swamp Rotifera. Several of the species occurring in the Illinois River and not found in the Great Lakes have been found in swamps or small bodies of water in immediate proximity to the lakes. This is true for example of *Trochosphæra solstitialis.* On the other hand, the fauna of the Great Lakes is marked by the presence of a number of distinctly limnetic Rotifera not found in the Illinois River, such as *Floscularia mutabilis* Bolton, *F. pelagica* Rousselet, *Conochilus volvox* Ehr., *Notops pelagicus* n. sp., *Notommata monopus* Jennings, *Plœsoma hudsoni* Imhof, *Gastropus stylifer* Imhof, and *Anapus ovalis* Bergendal.

A striking characteristic of Lake Erie, as exhibited during the summer of 1898, was the poverty in limnetic Rotatoria. In others of the Great Lakes the Rotifera have been found to form at times a considerable portion of the plankton. In Lake Erie the proportion formed by them was so small as to be hardly noticeable. The following 12 limnetic forms were seen; none of them were abundant and most of them were rare: *Floscularia mutabilis* Bolton, *F. pelagica* Rousselet, *Conochilus unicornis* Rousselet, *Asplanchna priodonta* Gosse, *Synchæta stylata* Wierzejski, *Polyarthra platyptera* Ehr., *Notops pelagicus* n. sp., *Anuræa cochlearis* Gosse, *Notholca longispina* Kellicott, *Plœsoma lenticulare* Herrick, *Gastropus stylifer* Imhof, and *Anapus ovalis* Bergendal. This list contains one species not hitherto found in others of the Great Lakes, namely, *Notops pelagicus* n. sp. On the other hand, the following species found in others of the Great Lakes were not found in Lake Erie: *Conochilus volvox* Ehr., *Asplanchna herrickii* de Guerne, *Plœsoma hudsoni* Imhof, *Notommata monopus* Jennings, and *Anuræa aculeata* Ehr. The first of these has been found in Lake Erie by another observer; the others have not.

The littoral, bottom, and swamp Rotifera of Lake Erie are, on the other hand, very abundant, as shown by the fact that 120 species have already been recorded from this lake. The shallow and marshy parts of the lake teem with rotifers.

Investigation of the Rotifera is as yet far too incomplete to draw very positive conclusions in regard to the geographical distribution of these animals. The evidence of all kinds, so far as it goes, seems to indicate that the following is true: Whether any given rotifer shall be found in a given body of water depends, not upon the locality of this body of water, not upon its connection with or separation from any particular drainage system, but upon the conditions present in that particular body of water. In stagnant swamps all over the world are likely to be found the characteristic Rotifera of stagnant water, with little regard to the country in which the swamp is found; in clear lake water will be found everywhere the characteristic limnetic Rotifera; in sphagnum swamps everywhere the sphagnum Rotifera. Variation in the rotifer fauna of different countries is probably due to variation in the conditions of existence in the waters of these countries, not to any difficulty in passing from one region to another. The Rotatoria are thus potentially cosmopolitan, any given species occurring wherever on the earth the conditions necessary to its existence occur. The number of different sorts of Rotifera to be found in any given region depends, then, upon the variety of conditions to be found in the waters of this region. Two bodies of water a half mile apart, presenting entirely different conditions, are likely to vary more in the make-up of their rotifer faunas than two bodies of water 5,000 miles apart that present similar conditions. Of course on this view it is likely that the Tropics will have many characteristic species not found in the cooler regions, since the Tropics present many conditions of existence not found elsewhere, and the same may be true of Arctic regions. The problem of the distribution of the Rotifera is, then, a problem of the conditions of existence, not a problem of the means of distribution. The ability of the eggs to live in dried mud, which may be carried about on the feet of birds or blown about as dust by the winds, seems to give sufficient opportunity to any species to multiply wherever occur the conditions necessary to its existence.

The fact that different rotifers do thus require different conditions for existence is, of course, evident to all who have worked on the group. A striking example of the fact that it is the life conditions, not the means of distribution of the animals, that determines the character of the fauna in a given body of water is given by a com-

parative study of the Rotifera of one of the swamps on South Bass Island and of those in the parts of Lake Erie immediately adjoining. This swamp lies near the United States fish-hatchery, on a narrow point of land, so that the distance to the lake is not great on either side. On the east the lake is about 50 feet away, and the lake and the swamp are connected by a small channel. Under usual conditions the water flows from the swamp through this channel into the lake. The swamp is shallow and its muddy bottom is covered by a dense growth of *Ceratophyllum*, while its surface is completely mantled by *Lemna*, *Spirodela*, and *Wolffia*. In this swamp occurs a characteristic fauna, *Rotifer tardus*, *Brachionus militaris*, *Brachionus bakeri*, *Apsilus*, *Monostyla quadridentata*, *Diplax trigona*, *Diglena biraphis*, *Metopidia ehrenbergii*, *Distyla gissensis*, *Notops clavulatus*, *Trochosphæra solstitialis*, etc. Almost the only one of these that is common in the adjacent lake is the ubiquitous *Monostyla quadridentata*. Towings in the lake just outside the mouth of the swamp reveal *Anuræa cochlearis*, *Synchæta stylata*, *Floscularia mutabilis*, *F. pelagica*, *Asplanchna priodonta*, *Notholca longispina*, and other characteristic limnetic Rotifera, while the bottom of the lake has likewise a fauna differing markedly in character from that of the swamp. At certain times, under a northeast wind, the water of Lake Erie is driven toward the west end of the lake, where it rises much above the usual level. At these periods the direction of the current in the channel above mentioned is reversed, and water flows from the lake into the swamp, which therefore likewise rises a foot or more. At such times all the characteristic limnetic Rotifera of the lake above mentioned are found in the swamp. There is thus at intervals a thorough intermixing of the two faunas. Yet in a short time after the lake has returned to its usual level it is found that the swamp has again only its characteristic swamp fauna, while the limnetic forms from the lake have entirely disappeared.

Certain rotifers thus require very special conditions of existence, and such conditions may exist only in a limited area, so that the rotifer will be confined to this area. Yet if the conditions do recur in any even distant part of the globe, the same rotifer is likely to be found there also. The history of *Trochosphæra*, for example (see p. 77), seems to bear out this conclusion.

DARTMOUTH COLLEGE, HANOVER, N. H., *May 29, 1899.*

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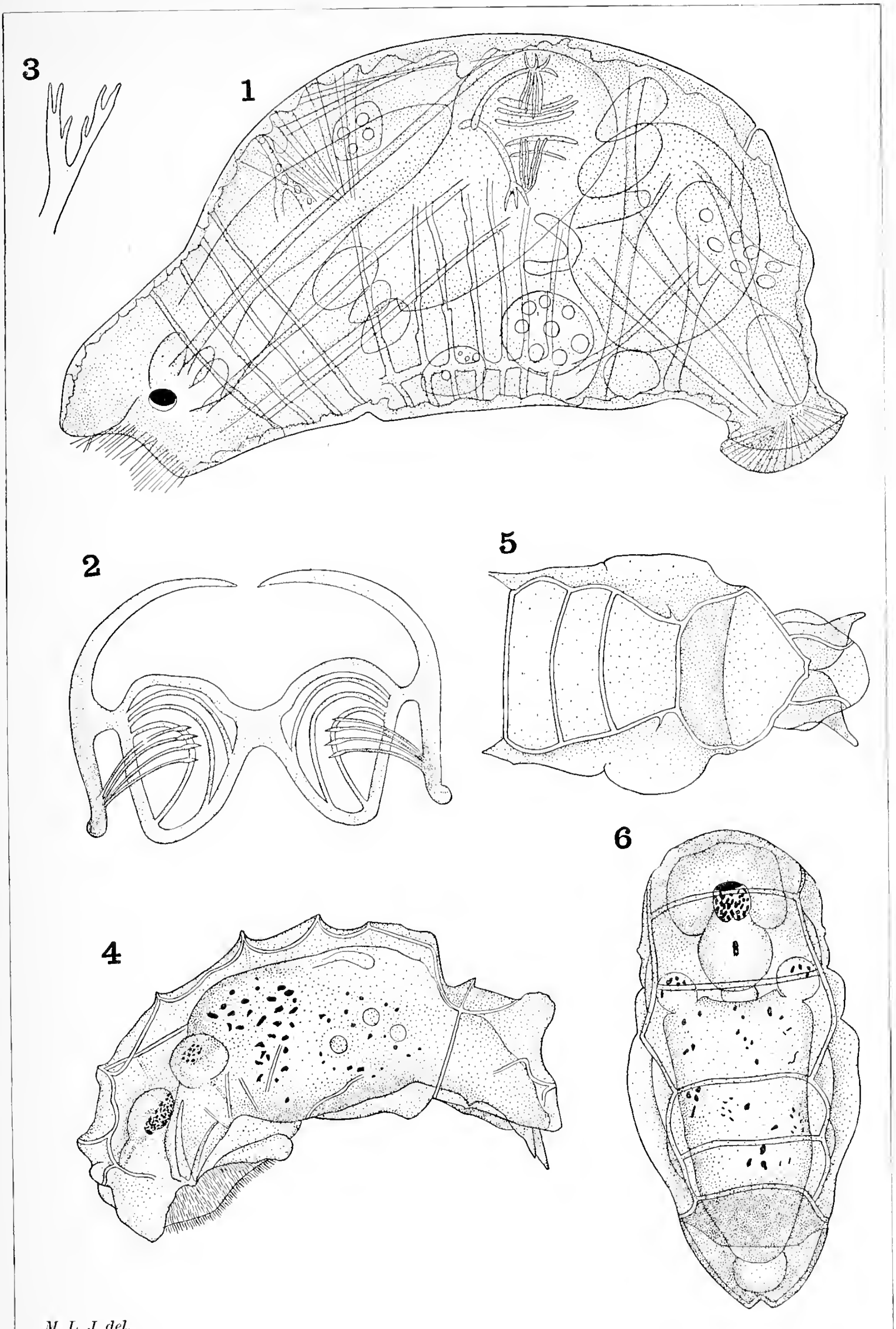

Fig. 1. Apsilus, young, free-swimming individual. Side view.

Fig. 2. Trophi of young Apsilus.

Fig. 3 Branched dorsal hooks of Œcistes melicerta Ehr.

Fig 4. Taphrocampa annulosa Gosse. Side view. (× 640.)

Fig. 5. Taphrocampa annulosa Gosse Dorsal view of posterior three-fourths of body, showing the broad "tail" and the toes. (× 640.)

Fig. 6. Taphrocampa annulosa Gosse, as seen from above; body curved so that the foot is not visible. (× 640.)

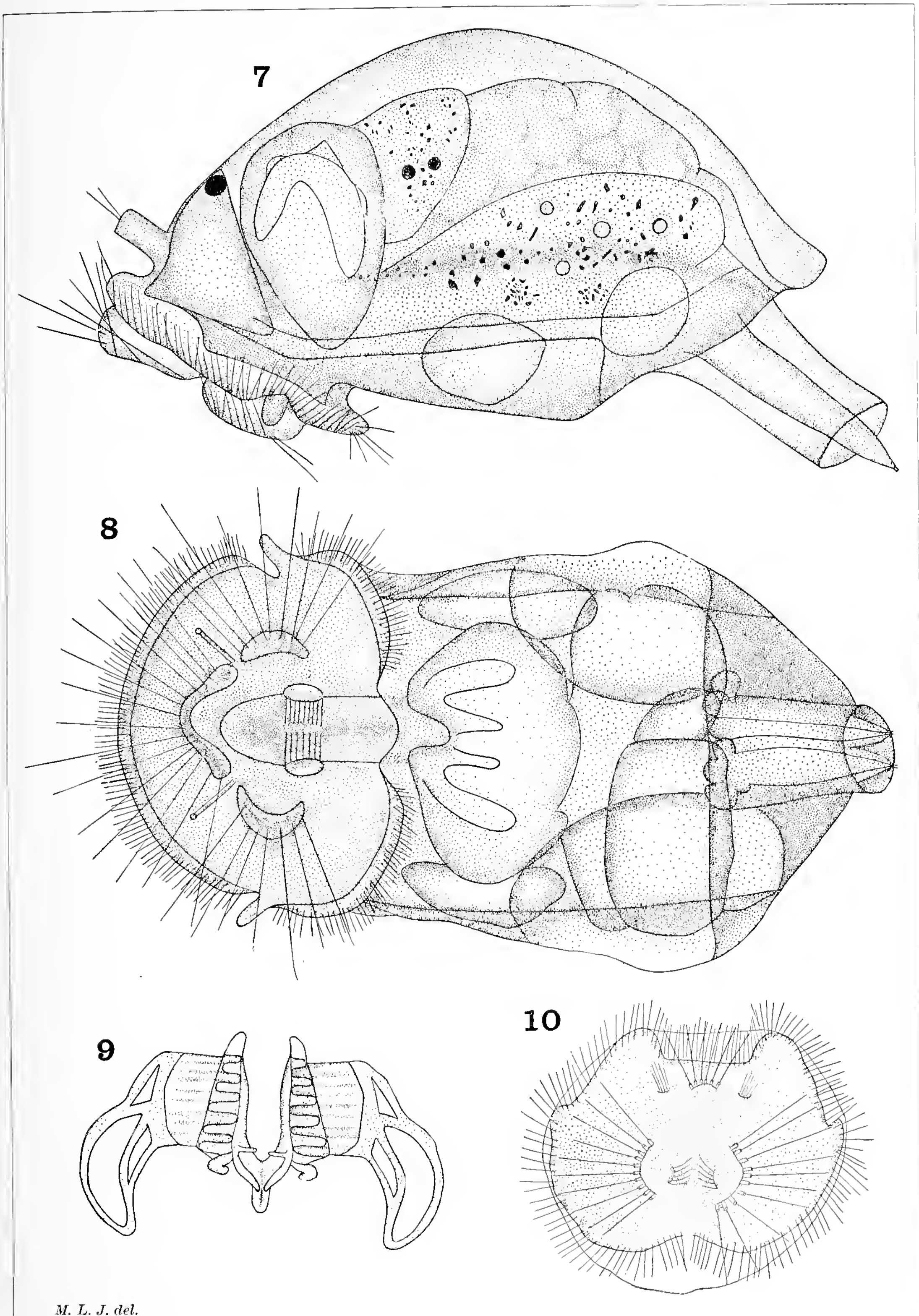

Fig. 7. Notops pelagicus n. sp. Side view. (× 800.)
Fig. 8. Notops pelagicus n. sp. Ventral view. (× 800.)

Fig. 9. Notops pelagicus n. sp. Trophi.
Fig. 10. Corona of Notops clavulatus Ehr.

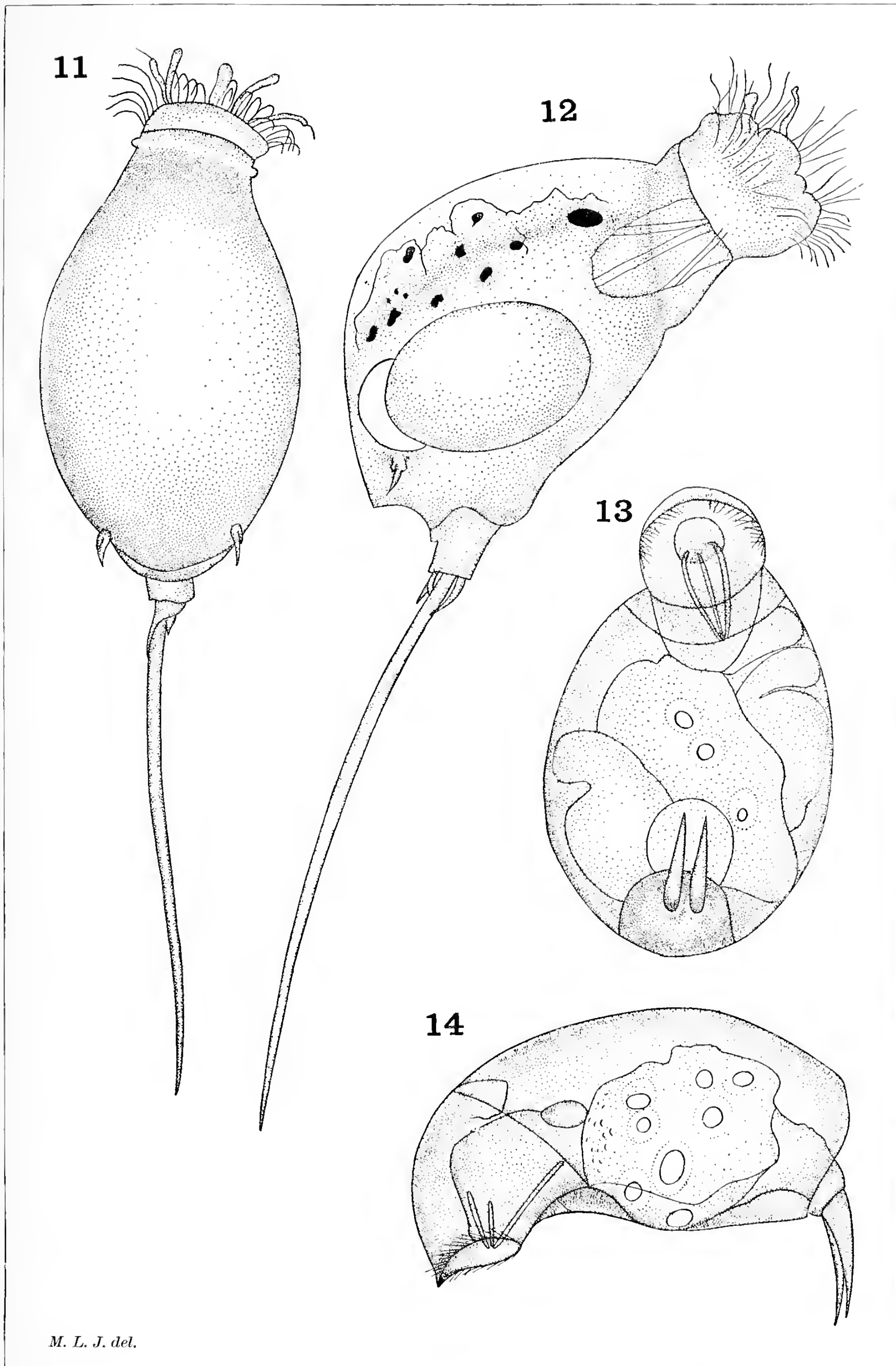

Fig. 11. Mastigocerca bicuspes Pell. Dorsal view (× 640.)
Fig. 12. Mastigocerca bicuspes Pell. Side view. (× 640.)
Fig. 13. Pleurotrocha parasitica n. sp. Ventral view. (× 640.)
Fig. 14. Pleurotrocha parasitica n. sp Side view (× 640.)

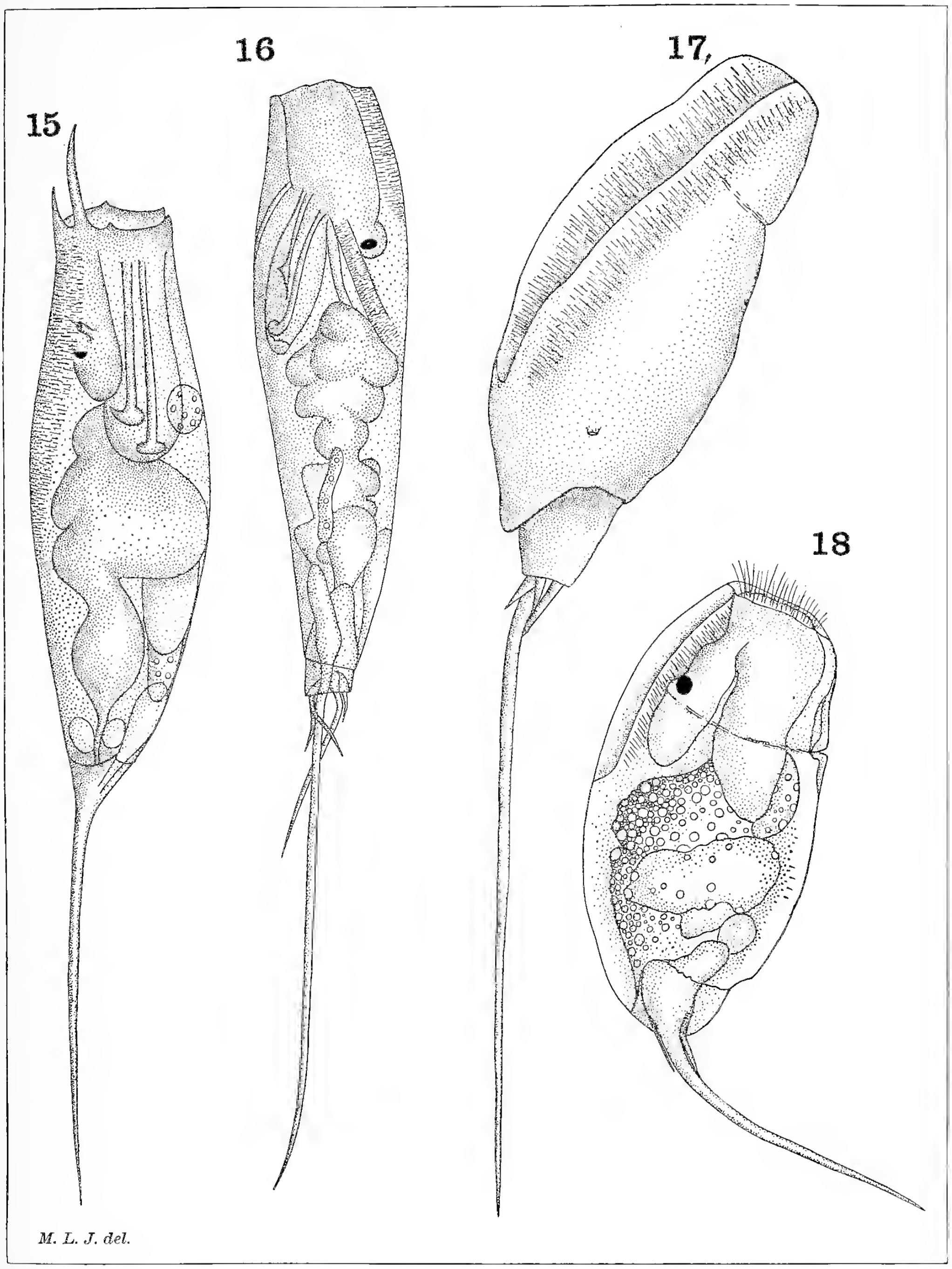

Fig. 15. Mastigocerca bicornis Ehr. Side view. (× 285.)
Fig. 16. Mastigocerca elongata Gosse. Side view. (× 285.)
Fig. 17. Mastigocerca bicristata Gosse. Side view of lorica, showing the two ridges. (× 490.)
Fig 18. Mastigocerca mucosa. Side view, showing the furrow between two dorsal ridges. (× 490.)

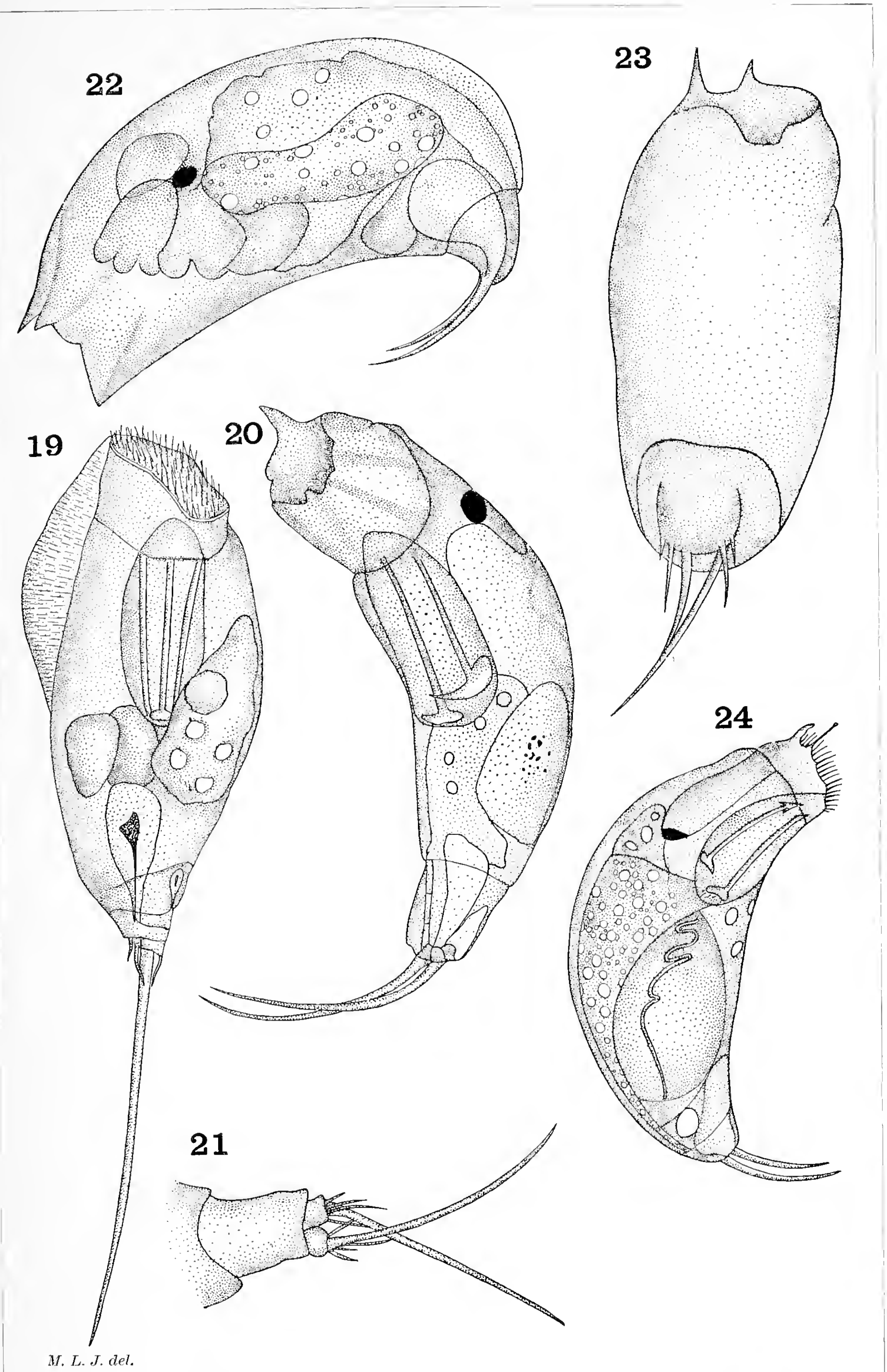

Fig. 19. Mastigocerca carinata Ehr. Side view. (× 490.)

Fig. 20. Rattulus tigris Müller. Side view of retracted animal. (× 640.)

Fig. 21. Rattulus tigris Müller, foot. Ventral view, with the two main toes crossed, showing the four substyles at the base of each toe.

Fig. 22. Cœlopus porcellus Gosse. Side view of retracted animal (× 640.)

Fig. 23. Cœlopus porcellus Gosse. Ventral view of lorica, showing the two teeth at the anterior margin and the six styles on the foot. (× 640.)

Fig. 24. Cœlopus brachyurus Gosse. Side view of specimen with head extended. (× 640.)

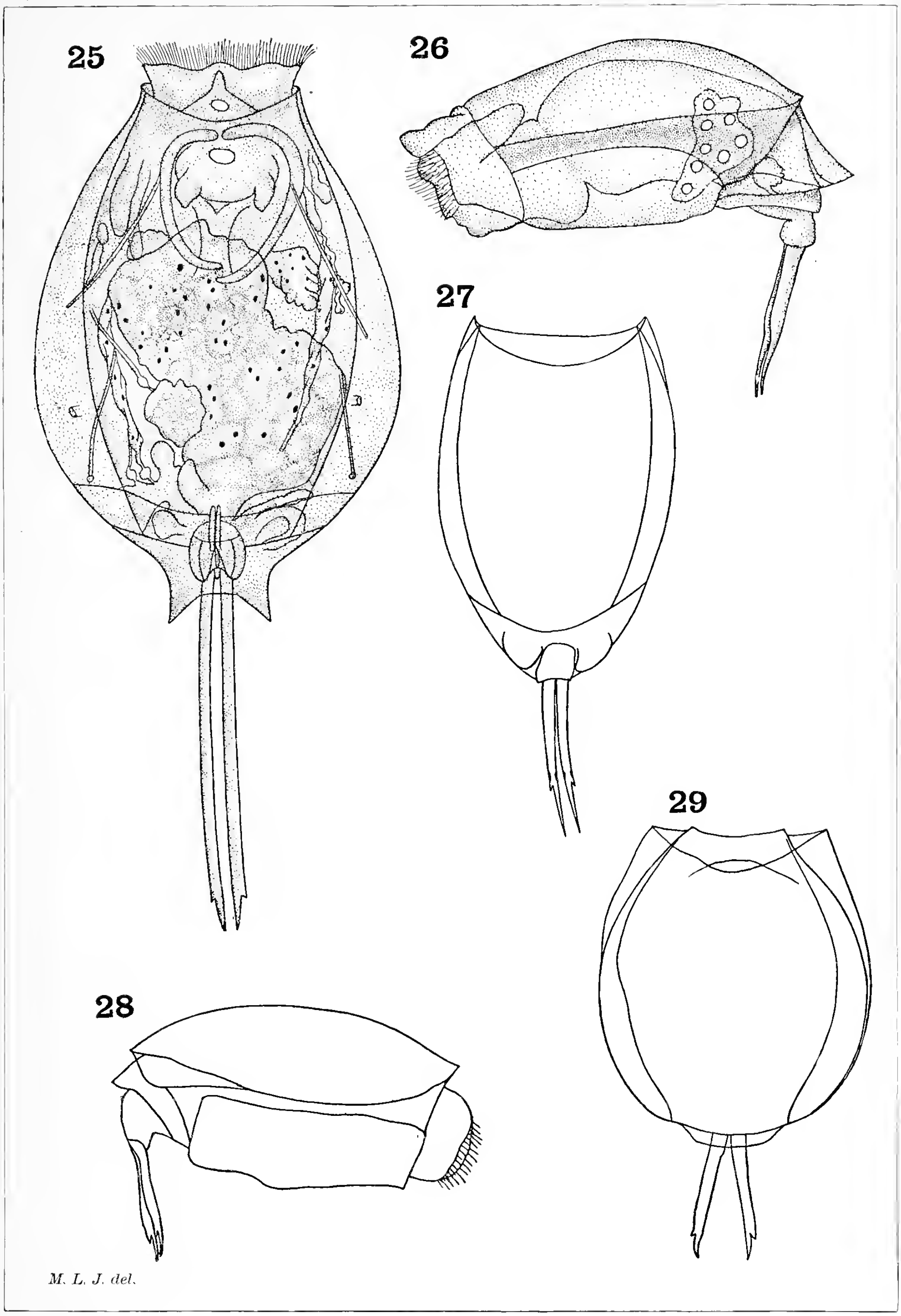

Fig. 25. Cathypna leontina Turner. Dorsal view (× 490.)
Fig. 26. Cathypna ungulata Gosse. Side view (× 215.)
Fig. 27. Cathypna ungulata Gosse. Outline of ventral view of smaller specimen. (× 215.)
Fig. 28. Cathypna luna Ehr. Side view. (× 365.)
Fig. 29. Cathypna luna Ehr. Ventral view. (× 365.)

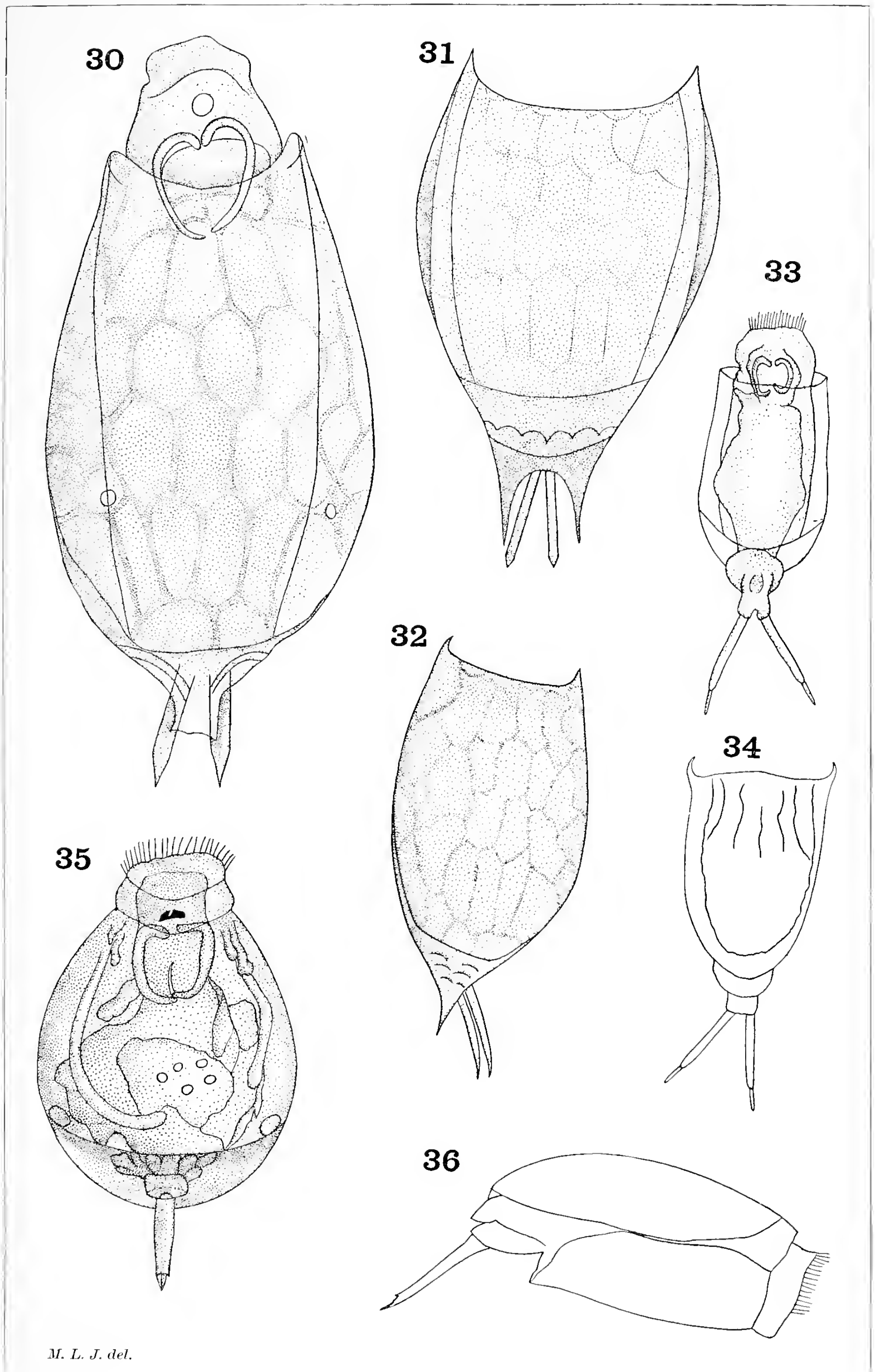

Fig. 30. Distyla ohioensis Herrick. Dorsal view. (× 640.)

Fig. 31. Distyla stokesii Pell. Dorsal view of lorica, showing the arrangement of the facets. (× 460.)

Fig. 32. Distyla ludwigii Eckstein. Dorsal view of lorica (× 385.)

Fig. 33 Distyla gissensis Eckstein. Dorsal view of partially extended animal. (× 315.)

Fig. 34. Distyla gissensis Eckstein. Dorsal view of completely retracted animal. (× 315.)

Fig. 35. Monostyla cornuta Ehr. Ventral view. (× 365.)

Fig. 36. Monostyla cornuta Ehr. Side view. (× 365.)

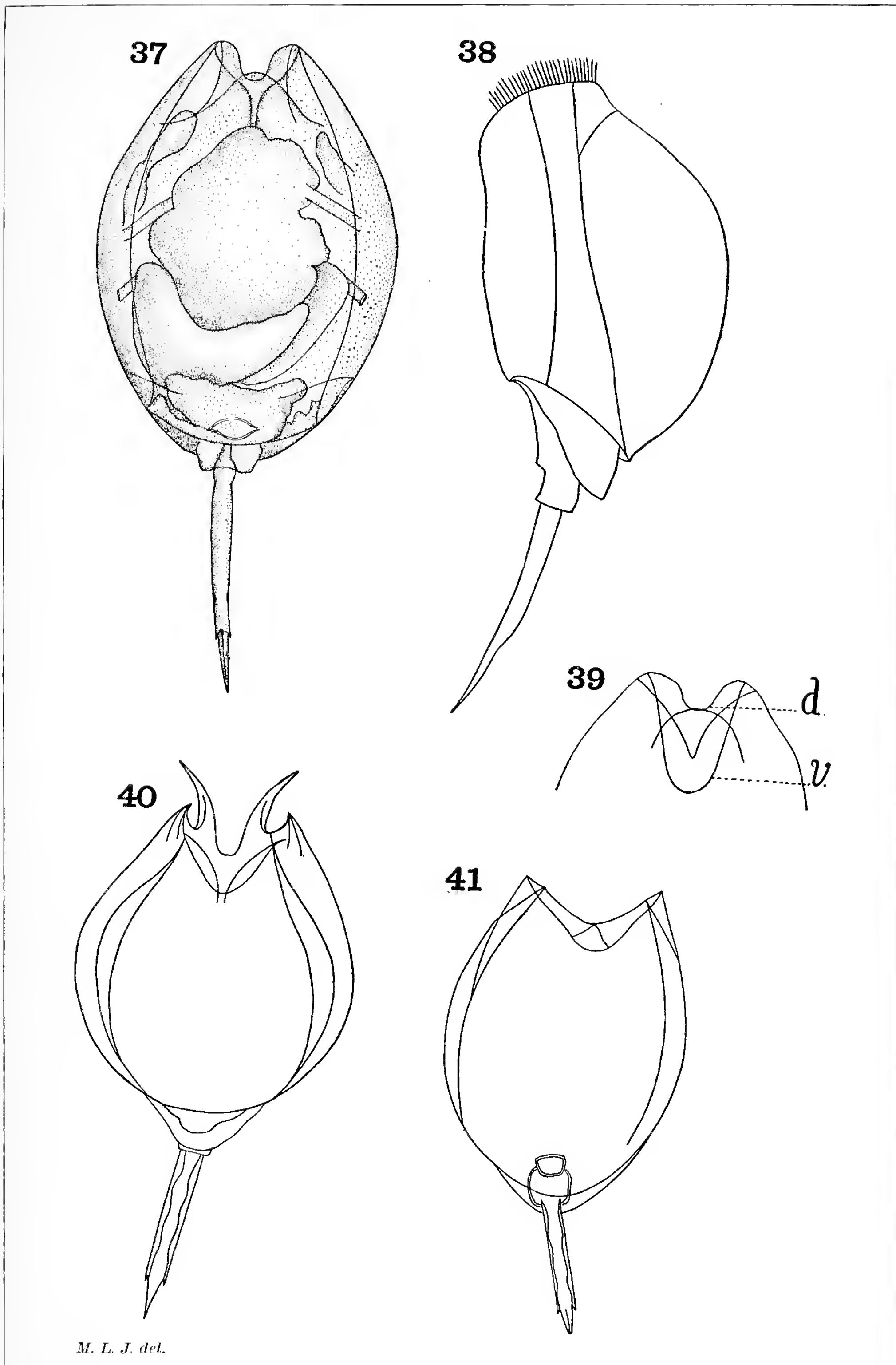

Fig. 37. Monostyla bulla Gosse. Dorsal view. (× 480.)
Fig. 38. Monostyla bulla Gosse. Side view. (× 480.)
Fig. 39. Monostyla bulla Gosse. Anterior margin of lorica in retraction, showing notches in dorsal and ventral plates of the lorica. *d*, Dorsal notch; *v*, ventral notch.

Fig. 40. Monostyla quadridentáta Ehr. Dorsal view.
Fig. 41. Monostyla lunaris Ehr. Ventral view, retracted. (× 315.)

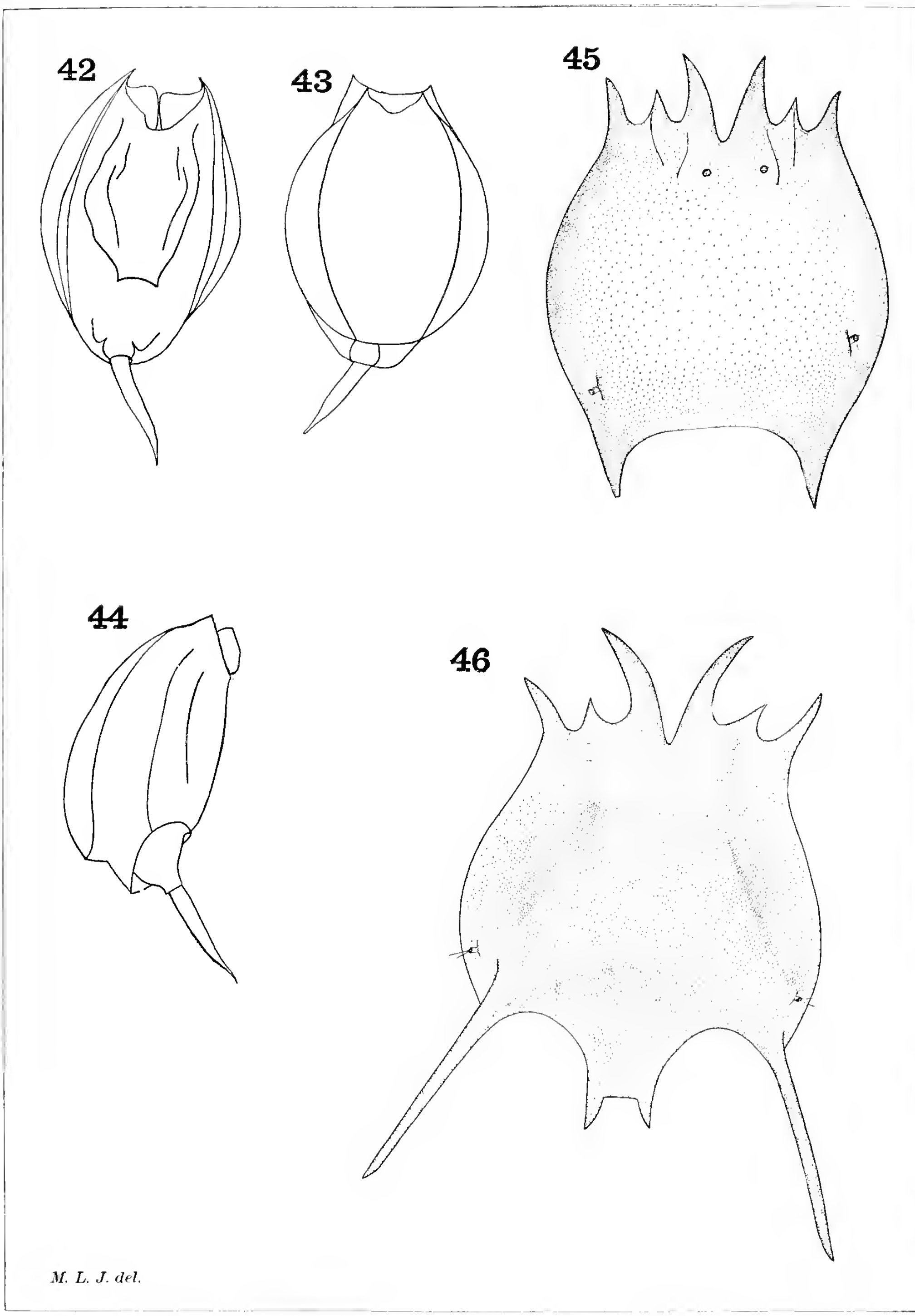

Fig. 42. Monostyla hamata Stokes. Ventral view. (× 480.)
Fig. 43. Monostyla hamata Stokes. Dorsal view. (× 480.)
Fig. 44. Monostyla hamata Stokes. Side view. (× 480.)

Fig. 45. Brachionus bakeri Ehr. Short-spined variety, from pools on the rocky surface of Starve Island.
Fig. 46. Brachionus bakeri Ehr. Long-spined variety, from swamps of South Bass Island.

CONTRIBUTIONS TO THE BIOLOGY OF THE GREAT LAKES.

A REPORT OF WORK ON THE PROTOZOA OF LAKE ERIE, WITH ESPECIAL REFERENCE TO THE LAWS OF THEIR MOVEMENTS.*

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The general plan of work outlined in the preceding paper for a study of the Rotatoria in their relations to the life conditions of the lake would apply equally, with some changes, to the Protozoa or to almost any other group of animals. In the study of the Protozoa it was decided to strike at once for the heart of the matter by beginning an investigation of the laws of their activities. A typical and very abundant Infusorian, *Paramecium caudatum*, was selected for special examination, and a study was made of the nature of its activities and the laws which govern them, in the hope that a full knowledge of such laws in the case of one Protozoan might furnish a key to an understanding of the activities of other members of the group, as well as, in time, to those of higher animals. The results of this work have already been published in detail elsewhere, so that a brief résumé is all that will be presented here.

The work was successful in determining the general mechanism of the reactions of Paramecium to changes in the external conditions, and in showing that the reactions are of the same essential nature in many other Protozoa. It was shown that the reactions of Paramecium are of extraordinary simplicity. As will be recalled by most biologists, Paramecium is a somewhat cigar-shaped animal, with one end narrow and blunt, the other broad but pointed. From the blunt end a groove passes obliquely along one side of the body to the middle, ending there in the mouth. The side on which the mouth and groove lie may be distinguished as the oral side; the opposite side (on which the contractile vacuoles lie) as the aboral side. The entire surface of the animal is covered with cilia, by means of which it moves. As it more usually moves in the direction of the narrower, blunter end, that may be called the anterior end, the other the posterior end.

In what might be called the normal condition of affairs all of the cilia strike backward, so that the animal moves forward; at the same time it revolves on its long axis. Now, when a change is produced in the environment of the Paramecium, such as by it striking against an obstruction or passing into water of different chemical content or different temperature, the normal activity is modified in one of two ways:

1. If the Paramecium comes in contact with a solid body of a loose fibrous texture, its activity is decreased; the cilia on the surface of the body cease their

* The papers in this series are based on investigations of the U. S. Fish Commission under direction of Prof. Jacob Reighard, of the University of Michigan. The following have already appeared:

The Mechanism of the Motor Reactions of Paramecium. <Am. Jour. Physiology, vol. II, pp. 311-341.

Laws of Chemotaxis in Paramecium. <Am. Jour. Physiology, vol. II, pp. 355-379.

movement, while those in the oral groove and the gullet continue active. As a consequence locomotion ceases; the animal comes to rest against the solid body, while the cilia of the oral groove continue to drive a stream of water to the mouth. This reaction to a solid body may be called thigmotaxis. If the loose solid body is a mass of bacterial zooglœa, the stream of water carries numbers of bacteria to the mouth, where they pass into the internal protoplasm of the animal and are digested; thus Paramecium gets its food. But the animal conducts itself in exactly the same way toward other loose fibrous bodies, such as bits of cloth, paper, sponge, or the like, the presence or absence of material that will serve as food having nothing to do with the production of the reaction. On the other hand, the substances held in solution in the water have a marked effect on the tendency of the Paramecia to react in the manner above described. If the water is faintly acid in reaction, the Paramecia are much more inclined to come to rest as just described. This is especially noticeable in water containing carbon dioxide. The presence in the water of an alkali in solution has, on the other hand, precisely the opposite effect, tending to inhibit the thigmotactic reaction.

2. Any other change in the conditions, of such a nature as to act as a stimulus, causes a definite change in the movements, which is of a stereotyped character, being of the same nature for almost every stimulus. When stimulated, Paramecium swims backward, turns toward its own aboral side, then swims forward again. The same reaction is produced by stimuli of the most varied kinds—by acids, alkalis, and neutral salts, by heat, by cold, by mechanical shock. The reaction is the same whether the stimulus first affects the anterior end, the posterior end, one side, or the entire surface of the animal at once. The direction in which the animal swims has thus no relation to the localization of the stimulus. If the stimulus comes from the anterior end, swimming backward of course carries the animal away from it; if the same stimulus comes from the posterior end, swimming backward carries the animal toward it. If an injurious chemical substance diffuses in such a way as to first come in contact with the posterior end of a resting Paramecium, the latter therefore swims backward directly into the substance and is killed. The turning is likewise without relation to the position of the stimulus. The animal always turns toward its own aboral side, so that the absolute direction in which it turns depends upon the chance position of the aboral side when the turning begins. As the animal continually revolves, both when swimming forward and when swimming backward, it is impossible to predict in which direction the aboral side will lie after the animal has swum backward a distance from its position when stimulation occurs; and observation shows that when Paramecium strikes on one side against an obstruction, it is fully as likely to turn toward the obstruction, after swimming backward, as to turn away. In the former case it of course strikes the obstruction again; the whole reaction is then repeated. Owing to the continual rotation on the long axis, the aboral side will probably be in a new position next time, so that the animal will turn in a new direction. If this repetition is continued, the Paramecium is certain finally, by the laws of chance, to avoid the obstacle.

The factors determining the direction of motion in Paramecium are thus internal; the direction of its movements has no relation to the position of external objects. This result is of fundamental significance for interpretation of the movements of these creatures, and throws a flood of light on many of the phenomena of their life. Study of some other Infusoria in the light of the result on Paramecium has shown that the

same is true for these. *Spirostomum ambiguum* when stimulated contracts, swims backward, turns toward the aboral side, and swims forward. If touched with a spicule of glass at its anterior end it swims backward, *away* from the glass; if touched at the posterior end it likewise swims backward, therefore *toward* the glass. *Stentor polymorphus* when stimulated contracts, swims backward, turns to the right, then swims forward, the direction of motion having, as in the other cases, no relation to localization of the stimulus. Similar results, not yet published in detail, have been obtained with certain Flagellata, as well as with other Ciliata.*

Besides determining the general mechanism of the reactions of Paramecium, an extended study was made of the effects upon its activities of different chemicals. If into a preparation of Paramecia mounted upon the slide a drop of some chemical substance in solution is introduced, the Paramecia may either collect in the drop or leave it entirely empty. In the former case they show positive chemotaxis to the substance; in the latter case, negative chemotaxis. As to what might be called the mechanism of chemotaxis, the following was made out. The Paramecia are not attracted by the drop of substance into which they gather. They may graze the very edge of the drop without swerving a particle from their course so as to pass into it. But Paramecia when first brought upon the slide swim rapidly in every direction, so that many will quickly come by chance against the edge of such a drop. They do not react, but swim straight ahead—the substance in the drop not acting as a stimulus to produce the motor reaction above described. But on passing across the drop, the outer fluid does, after the Paramecia have been in the drop of the chemical, act as a stimulus to produce the motor reaction. The Paramecium therefore, on coming to the outer edge of the drop, swims backward, thus returning into the drop. It then turns toward the aboral side and swims forward (in accordance with the general scheme of reaction above described). It thus comes to the outer edge of the drop once more; reacts again, and this being kept up, is continually prevented from crossing the boundary of the drop into the surrounding water. The same process is repeated for many Paramecia, until in time the drop swarms with the Infusoria, so that they appear to have been attracted into it.

In case of a substance in which the Paramecia do not collect at all, observation shows that the motor reaction (swimming backward, turning, and swimming forward) is produced when the Paramecia come against the drop from the outside; hence they are prevented from entering and the drop remains empty.

It was found possible to classify chemical compounds thus into two classes. On the one hand may be placed together those which do not produce the reaction when the Paramecia enter them, but throw the animals into such a physiological condition that they do react when they pass out of a drop containing the substance in question. In these the Paramecia, therefore, gather and are said to be positively chemotactic toward them. On the other hand are substances which produce the motor reaction as soon as the Paramecia come in contact with them, so that the animals do not enter

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* The reactions of a large number of Protozoa have been studied since the above was written. In all of these the direction of turning was found to be determined entirely by internal factors, and to have no relation to the position of the source of stimulus. The direction of motion along the body axis, on the other hand, was found in a number of cases, for mechanical stimuli, to be determined by the localization of the stimulus. *Loxodes rostrum*, for example, when touched with a glass rod at the anterior end swims backward; touched at the posterior end it swims forward. For chemical stimuli, however, the *absence* of any such dependence of the direction of movement on the localization of the stimulus was demonstrated. For details, see a paper by the author on "The movements and motor reflexes of the Flagellata and Ciliata," in the American Journal of Physiology, January, 1900.

solutions of these compounds at all, and may be said to be negatively chemotactic toward them.

In the former group (substances toward which the Paramecia show positive chemotaxis) belong all acids, and salts whose solutions have an acid reaction or contain hydrogen ions, as in salts of the heavy metals. In the group of substances toward which the Paramecia are negatively chemotactic belong all alkalies and substances having an alkaline reaction, as well as almost all compounds which contain ions of the alkali and earth alkali metals in their solutions. Certain substances take an intermediate place. Containing the ions of an alkali or earth alkali metal, they produce the motor reaction when the Paramecia enter a drop of fluid containing them; but having likewise hydrogen ions, they also cause the animals to react when they leave the drop. Examples of such substances are potassium and ammonium bichromate. In these cases the hydrogen ions seem to be active (in their characteristic way) in a more dilute solution, and, therefore, farther from the center of a diffusing drop than are the ions of the metals. The Paramecia, therefore, enter the outer margin of the drop and are unable to leave it, while at the same time they are unable to pass to the center of the drop. They thus gather in a ring about the drop, leaving the center empty.

The classification of substances into those toward which the Paramecia are positively chemotactic on the one hand and those toward which they are negatively chemotactic on the other, thus follows the lines of a chemical classification; the former including acids, the latter alkalies and salts of the alkali and earth alkali metals.

Experimentation showed that the relative injuriousness of solutions has comparatively little to do with the nature of the chemotaxis. Paramecia are repelled strongly by many substances that are scarcely injurious at all, while they enter without hesitation other substances in which they are at once killed. The repellent powers of different chemical compounds are in no way proportional to their injurious effects.

The researches on chemotaxis have thus far been restricted almost entirely to Paramecium, but the general laws obtained for this animal promise to throw much light on related phenomena in others.

As described above, positive and negative chemotaxis, or the collecting in or avoidance of certain chemicals, takes place through the mechanism of the general motor reaction first described. The only activity of the Paramecia concerned in it all is the swimming backward, turning toward the aboral side, then swimming forward, when stimulated. The qualitative differences that seem apparent in their reactions toward different substances depend merely upon what does and what does not act as a stimulus.

The mechanism of collecting in or avoiding agencies or conditions, other than chemical, is exactly the same as that just described. In the case of temperature, for example, certain grades of heat or cold produce motor reaction, so that the Paramecia do not enter these; or, if already within a zone of such temperature, they continue moving about violently till a chance movement carries them into a region where the temperature is not such as to cause a reaction; there they remain. In general, therefore, the Paramecia gather and remain in substances or conditions which do not cause the motor reaction, while they leave empty such substances or conditions as do cause their one motor reaction. It follows that they collect in regions of a certain temperature, avoiding great heat or cold, and that they collect in water holding in solution substances of an acid character, avoiding alkaline solutions. Under natural con-

ditions, their collecting into regions acidulated by carbon dioxide excreted by themselves is particularly noticeable. It results in bringing the Paramecia together in dense swarms. To this is to be added, as a second factor in bringing the Paramecia together, the fact that contact with solids of a loose fibrous texture likewise tends to quiet the Paramecia, so that they collect about such solids. In the fluids in which the Paramecia live, such solids are present as masses of bacterial zooglœa, upon which the Paramecia will usually be seen to be collected in swarms.

The ordinary life of a Paramecium may then be summarized somewhat as follows: In the free water, as long as the animal is unstimulated, it swims forward in a spiral course, revolving on its long axis. But it comes in contact here and there with changes in the environment—regions of higher or lower temperature, or of greater or less amounts of certain chemicals in solution, or with mechanical obstructions. If these changes are of such a nature as to act as a stimulus, the Paramecium thereupon swims backward a short distance, turns toward one side (in a direction which is an entirely random one so far as outer objects are concerned) and continues forward. This reaction is repeated as often as the Paramecium comes in contact with any source of stimulus. Certain solutions or conditions cause no reaction. Thus the Paramecium may pass by chance into a group of other Paramecia, where the water is charged with carbon dioxide, which they have excreted. Now, the surrounding water containing *no* carbon dioxide causes the reaction, so the Paramecium remains with the others. Or, if it comes in contact with a loose, soft body it stops, only the oral cilia continuing to be active. These constantly carry a stream of water to the mouth, and if the solid is by chance a bit of bacterial zooglœa, this stream carries many bacteria into the mouth of the animal, so that they serve as food. But if no bacteria are present, the Paramecium nevertheless remains indefinitely against the bit of solid, especially if joined by other individuals, so that they are in a region containing carbon dioxide (excreted by themselves).

This resting condition may be brought to an end by too high or too low a temperature, by the diffusion of an alkali into the water, or by various other conditions that tend to produce a motor reaction. The Paramecium then continues on its way in some chance direction till it comes again into conditions which do not act as a stimulus.

Thus the life of the animals is extremely simple; they have but one mode of reaction to outer conditions—by swimming backward, turning, swimming forward—while under other conditions their activity largely ceases.

It is obvious that such simple activities, while they do result in keeping Paramecia out of certain conditions and bringing them into others, would not be adequate for preserving the animals under complicated and changing conditions. The Paramecia show no indication of intelligence or even of choice, reacting to everything in the same manner, if they react at all. They have no power of adapting their actions to their needs. Chance is the main factor in bringing the Paramecium into proper conditions and giving it food, and if the chances are not favorable the animals must soon die. This agrees perfectly with the facts observed in cultures of these and similar animals. So long as the conditions are exactly right—bacterial zooglœa covering everything, so that the Paramecia can not miss it, and the chemical condition of the water entirely favorable—the animals swarm and multiply by thousands. A slight change occurs in the conditions, and soon scarcely a Paramecium is to be found, though a few hours previously the water was milky with them. As in the case of plants, the proper conditions are the chief requisite for growth and multiplication;

these infusoria appear and disappear in the culture jar about as the lower algæ do. The power of movement, regulated in the simple manner above described, is correlated with the fact that, unlike plants, they live upon solid food (bacteria) and are therefore more likely to get this food if they can move about here and there. But the bacteria must be abundant in any case, for the Paramecia have no power of searching for them, or of choosing them rather than any other substance.

In future work it is hoped to determine how far the results gained on Paramecium are applicable to the Protozoa as a class, as well as to extend these researches to higher groups, building upon the foundation obtained by a study of these lowest organisms. In this way it is hoped that the laws which govern the movements and migrations of animals, the causes of their appearance and disappearance at certain places or under given conditions, and in fact much of their relations to the conditions surrounding them in the lake, may in time be made out. It is the belief of the writer that this is the most direct and certain way of unraveling the complicated network of relations which make up the life of the lake.

In addition to the study of the reactions of the animals above summarized, some faunistic work was carried on. An examination was made of the waters on and about South Bass Island, with the purpose of determining the abundance and general character of the Protozoan fauna. The swampy waters of this region were found to swarm with Protozoa of all sorts, offering unlimited supplies of material for work on the group in experimental or other lines. Unfortunately, the literature was not at hand for complete identification of all the species observed, so that critical systematic work, of the sort done on the Rotatoria, could not be carried on for the Protozoa. Only those could be positively identified that agreed completely with species described in the standard works on the Protozoa—Leidy's *Rhizopoda*, Kent's *Manual of the Infusoria*, Bütschli's *Protozoen*, Eyferth's *Die einfachsten Lebensformen des Thier-und Pflanzenreiches*, Bloehmann's *Die mikroskopische Thierwelt des Süsswassers*, Pritchard's *Infusoria*, Ehrenberg's *Die Infusionsthierchen als vollkommene Organismen*, etc.

The following list therefore contains the names of such species only as could be fully identified, and comprises thus but a fraction of the Protozoan fauna of the region. It is given in order to show something of the character of the abundant Protozoan fauna of these waters, as well as to point out forms that are of especial interest as favorable objects for investigation. Especial attention was paid to forms which from their size, or from the possibility of securing them in great abundance, promise to be particularly favorable for experimental work.

LIST OF SOME OF THE PROTOZOA FOUND IN THE WATERS ABOUT SOUTH BASS ISLAND, IN LAKE ERIE, DURING THE SUMMER OF 1898.

The waters examined were the same as those mentioned in the account of the Rotatoria. The list includes 68 species, distributed among the different groups as follows: Rhizopoda 13, Heliozoa 1, Mastigophora 21, Ciliata 32, Suctoria 1.

RHIZOPODA.

1. **Amœba proteus** Leidy. Taken in a water-bottle collection from the upper 3 feet of the surface of Lake Erie, 1 mile west of South Bass Island; also on *Elodea* from East Harbor and in the swamps on South Bass Island.
2. **Amœba villosa** Wallich. In the water-bottle collection from the upper 3 feet of the water of Lake Erie, 1 mile west of South Bass Island.
3. **Amœba radiosa** Ehrenberg. In the water-bottle collection from the upper 3 feet of the water of Lake Erie, 1 mile west of South Bass Island; also on *Elodea* from East Harbor, Lake Erie.
4. **Pamphagus hyalinus** Ehr. In surface towings in Put-in Bay Harbor, Lake Erie.
5. **Cochliopodium bilimbosum** Auerbach. In water-bottle collection from upper 3 feet of water of Lake Erie, 1 mile west of South Bass Island; also on *Elodea* from East Harbor, Lake Erie.
6. **Difflugia lobostoma** Leidy. In towings in Put-in Bay Harbor, Lake Erie; also from East Swamp on South Bass Island.
7. **Difflugia corona** Wallich. In surface towings from Put-in Bay Harbor, Lake Erie; also from East Harbor, Lake Erie; from Portage River, Ohio, and land-locked pools on Starve Island.
8. **Difflugia globulosa** Duj. In water-bottle collection from the surface 3 feet of Lake Erie, 1 mile west of South Bass Island; from surface towings in Put-in Bay Harbor; from East Harbor, and from the swamps on South Bass Island.
9. **Difflugia constricta** Ehr. In *Utricularia* from Portage River, Ohio.
10. **Difflugia pyriformis** Perty. In the swamp near the fish-hatchery on South Bass Island; in *Utricularia* from Portage River, Ohio.
11. **Arcella vulgaris** Ehr. In surface towings in Put-in Bay Harbor, Lake Erie; in East Harbor on *Elodea;* in the swamps on South Bass Island; from Portage River, Ohio.
12. **Centropyxis aculeata** Stein. In swamps on South Bass Island.
13. **Euglypha alveolata** Duj. Swamps on South Bass Island.

HELIOZOA.

14. **Acanthocystis chætophora** Schrank. In plankton haul from Lake Erie, just west of South Bass Island; on *Elodea* from East Harbor, Lake Erie.

MASTIGOPHORA.

15. **Oikomonas termo** J. Clark. Abundant on floating floccose material on the surface of Lake Erie, northeast of North Bass Island.
16. **Anthophysa vegetans** Müller. On *Elodea* from East Harbor, Lake Erie; from swamp on South Bass Island.
17. **Dinobryon sertularia** Ehr. On vegetation from East Harbor, Lake Erie.
18. **Euglena viridis** Ehr. In water-bottle collection from upper 3 feet of Lake Erie, taken 1 mile west of South Bass Island. Abundant in swampy parts of East Harbor, Lake Erie, and in the swamps on South Bass Island.
19. **Euglena spirogyra** Ehr. East Swamp, South Bass Island; Portage River, Ohio.
20. **Euglena oxyuris** Schm. East Swamp, South Bass Island.
21. **Amblyophis viridis** Ehr. East Swamp, South Bass Island.
22. **Colacium steinii** Kent. On *Diaptomus* sp. in surface towings from Lake Erie.
23. **Colacium vesiculosum** Ehr. On *Cyclops* in towings taken 2½ miles north of Kelley Island, in Lake Erie; on *Polyarthra platyptera* and various crustaceans in swamps on South Bass Island.
24. **Trachelomonas hispida** Perty. In East Swamp, on South Bass Island; from Portage River, Ohio.
25. **Trachelomonas volvocina** Ehr. Amid filamentous algæ from East Harbor, Lake Erie; from Portage River, Ohio; from swamps on South Bass Island.

26. **Trachelomonas aspera** Ehr. Swamp on South Bass Island.
27. **Trachelomonas armata** Ehr. In aquatic vegetation from East Harbor, Lake Erie, and from East Swamp on South Bass Island.
28. **Phacus longicaudus** Ehr. From East Harbor, Lake Erie, and from swamps on South Bass Island.
29. **Phacus triqueter** Ehr. East Harbor, Lake Erie, and East Swamp, South Bass Island.
30. **Astasia trichophora** Ehr. On *Elodea* from East Harbor, Lake Erie.
31. **Entosiphon sulcatum** Duj. In jar of decaying *Nelumbo lutea* from East Harbor, Lake Erie.
32. **Synura uvella** Ehr. East Swamp, South Bass Island.
33. **Chilomonas paramecium** Ehr. Abundant in decaying water-plants from any part of Lake Erie or the swamps on South Bass Island. This is one of the species that can always be procured in unlimited quantities at any time.
34. **Monosiga steinii** Kent. On stems of *Epistylis plicatilis* from East Swamp, South Bass Island.
35. **Peridinium tabulatum** Ehr. In water-bottle collection from upper 3 feet of Lake Erie, 1 mile west of South Bass Island; also in aquatic plants from East Harbor, Lake Erie, and from the swamps on South Bass Island.

CILIATA.

36. **Trachelocerca olor** O. F. M. In *Utricularia* from Portage River, Ohio.
37. **Coleps hirtus** Ehr. Swamp near fish-hatchery on South Bass Island.
38. **Amphileptus meleagris** Ehr. In aquatic plants from East Harbor, Lake Erie.
39. **Amphileptus margaritifer** Ehr. In aquatic vegetation from Put-in Bay Harbor and East Harbor, Lake Erie.
40. **Lionotus fasciola** Ehr. In aquatic plants from East Harbor, Lake Erie.
41. **Loxophyllum meleagris** Ehr. On *Myriophyllum* from East Harbor, Lake Erie.
42. **Trachelius ovum** Ehr. On *Utricularia* from Portage River, Ohio.
43. **Dileptus anser** O. F. M. On aquatic plants from Put-in Bay Harbor, Lake Erie, and the swamps near the fish-hatchery on South Bass Island.
44. **Nassula ornata** Ehr. East Harbor, Lake Erie; Portage River, Ohio; East Swamp, South Bass Island.
45. **Glaucoma scintillans** Ehr. Common in cultures of decaying lake plants.
46. **Colpidium cucullus** Schrank. Abundant in infusions of decaying *Ceratophyllum* from the bottom of Put-in Bay Harbor, Lake Erie.
47. **Paramecium caudatum** Ehr. Abundant in cultures of decaying lake plants from the bottom of Put-in Bay Harbor, Lake Erie. See pp. 105–110 for an account of the laws of the movements of this animal.
48. **Urocentrum turbo** O. F. M. Abundant in decaying *Ceratophyllum* from the bottom of Put-in Bay Harbor, Lake Erie; also in water from East Swamp on South Bass Island.
49. **Cyclidium glaucoma** Ehr. In jar of decaying *Nelumbo lutea* from East Harbor, Lake Erie; many.
50. **Spirostomum ambiguum** Ehr. East Harbor, Lake Erie, and the swamps on South Bass Island.
51. **Bursaria truncatella** Müller. This enormous infusorian was common in the swamp near the fish-hatchery on South Bass Island.
52. **Stentor cæruleus** Ehr. In aquatic vegetation from East Harbor, Lake Erie, from Portage River, Ohio, and the swamps on South Bass Island.
53. **Stentor igneus** Ehr. In *Elodea* from East Harbor, Lake Erie.
54. **Strombidium turbo** C. and L. In decaying *Nitella* from East Harbor, Lake Erie.
55. **Halteria grandinella** Müller. Many in *Utricularia* from Portage River, Ohio.
56. **Tintinnopsis cylindrica** Daday. An empty shell of what appears to be this species, recently described by Daday, was taken in the water-bottle collection from the upper 3 feet of Lake Erie, 1 mile west of South Bass Island.
57. **Codonella cratera** Leidy. In towings from Put-in Bay Harbor, Lake Erie. This seems to be the same as the European *Codonella lacustris*, but Leidy's name has the priority.
58. **Holosticha mystacea** Stein. In the water-bottle collection from the upper 3 feet of Lake Erie, 1 mile west of South Bass Island.
59. **Uroleptus musculus** Müller. Few in decaying *Nitella* from East Harbor, Lake Erie.
60. **Oxytricha fallax** Stein. Common in decaying *Ceratophyllum* from the bottom of Put-in Bay Harbor, Lake Erie.

61. **Trichodina pediculus** Ehr. On *Diaptomus* from towings in Put-in Bay Harbor; on *Hydra* from East Harbor, Lake Erie.

62. **Vorticella convallaria** L. Very abundant on algæ from East Swamp, South Bass Island.

63. **Vorticella chlorostigma** Ehr. Forming large green patches visible to the naked eye, on the vegetation from East Swamp, South Bass Island.

64. **Vorticella rhabdostyloides** Kellicott. Common on *Anabæna* in towings from Lake Erie.

65. **Zoothamnium arbuscula** Ehr. In surface towings in Put-in Bay Harbor, Lake Erie, attached to floating matter.

66. **Epistylis plicatilis** Ehr. Abundant on *Chara* from East Swamp, South Bass Island, in company with *Megalotrocha alboflavicans*.

67. **Vaginicola crystallina** Ehr. On aquatic plants from East Swamp, South Bass Island. What seems the same form is often found on *Fragillaria* in towings from Lake Erie; these specimens are always much smaller, however.

SUCTORIA.

68. **Acineta mystacina** Ehr. On floating floccose material taken with the tow net in Put-in Bay Harbor, Lake Erie.

While the fauna inhabiting the plants of the bottom and about the shores of this part of Lake Erie is very rich in Protozoa, both in the number of species and of individuals, the open waters of the lake contain very few. Though 22 species are included in the list, as taken from the waters of the lake away from shore, most of these were present in very small numbers, and none were abundant. The species of the foregoing list found in the open waters of the lake, and on that account apparently to be considered limnetic, are the following:

Amœba proteus.	*Acanthocystis chætophora.*	*Holosticha mystacea.*
Amœba villosa.	*Oikomonas termo.*	*Trichodina pediculus.*
Amœba radiosa.	*Euglena viridis.*	*Vorticella rhabdostyloides.*
Pamphagus hyalinus.	*Colacium steinii.*	*Zoothamnium arbuscula.*
Cochliopodium bilimbosum.	*Colacium vesiculosum.*	*Vaginicola crystallina* (?).
Difflugia corona.	*Peridinium tabulatum.*	*Acineta mystacina.*
Difflugia globulosa.	*Tintinnopsis cylindrica.*	
Arcella vulgaris.	*Codonella cratera.*	

This list includes a number of species not usually recorded from open-lake waters; these are chiefly due to Professor Reighard's collections with the water bottle, which were made as follows: A large corked bottle was sunk in the lake to the desired depth, the cork pulled from the mouth, and the water allowed to fill the bottle. The water thus secured was then filtered, so as to prevent the escape of even the most minute organisms. Collections were thus made from the open lake 1 mile from any land, where the water was 6 fathoms deep. Water was taken from the surface layer not more than 3 feet below the surface. Collections so made contained regularly a number of minute Protozoa not usually accounted limnetic, namely:

Amœba proteus.	*Cochliopodium bilimbosum.*	*Peridinium tabulatum.*
Amœba villosa.	*Difflugia globulosa.*	*Tintinnopsis cylindrica* (only once).
Amœba radiosa.	*Euglena viridis* (once).	*Holosticha mystacea.*

The list is remarkable especially for the three species of *Amœba* and one of *Cochliopodium*. These rhizopods are very minute, and would be lost by the usual methods of collecting. Continued thorough plankton work of the sort carried on by Professor Reighard may show that these are proper members of the limnetic fauna.

Difflugia globulosa was one of the very commonest limnetic forms in all sorts of collections from the open lake.

The passive limnetic forms included in the preceding list are:

Oikomonas termo, on floating floccose material.
Colacium steinii, on *Diaptomus*.
Colacium vesiculosum, on *Cyclops*.
Vorticella rhabdostyloides, on *Anabæna*.
Zoothamnium arbuscula, on floating material.
Vaginicola crystallina (?) on *Fragillaria*.
Acineta mystacina, on floating floccose material.

The following species may be noted as of special interest because of their fitness as objects of investigation in experimental or other lines:

Chilomonas paramecium is a flagellate form that can always be procured in unlimited numbers by simply allowing the aquatic plants to decay in jars. The necessity for large numbers in carrying on experimental work needs no emphasis. The ease with which a Protozoan can be cultivated in the laboratory is almost the most important element in its availability for investigation.

The species of *Euglena*, *Phacus*, and *Trachelomonas* are always to be had in large numbers from East Swamp, South Bass Island.

Trachelius ovum, *Dileptus anser*, and *Nassula ornata* are ciliates which are valuable for certain sorts of work on account of their large size. The same is true to a more pronounced degree of *Spirostomum ambiguum*, and especially of *Bursaria truncatella*. The latter is an enormous creature for a unicellular animal, being a millimeter or more in diameter. It could thus be handled in the same individual way as many of the large Metazoa. This animal was always procurable in small numbers from the swamp near the fish-hatchery on South Bass Island. Doubtless a little experimentation would discover a means of cultivating them in large numbers. Perhaps there is no other Protozoan that would be so favorable an object for an investigation into the effects of localized stimuli and into the question of the localization of functions in the Protozoan body or related problems.

Other ciliates that could always be procured in large numbers are *Glaucoma scintillans*, *Colpidium cucullus*, *Paramecium caudatum*, *Urocentrum turbo*, *Cyclidium glaucoma*, and *Vorticella convallaria*.

For Rhizopoda, three species of *Difflugia*—*D. globulosa*, *D. lobostoma*, and *D. corona*—are particularly abundant and might be used for work on this group. Cultures properly managed usually resulted in obtaining large numbers of various species of *Amœba*.

Species of *Volvox*, *Eudorina*, *Pandorina*, etc., swarm in East Swamp, South Bass Island; they are not included in the foregoing list. A study of the physiology of these creatures, transitional as they are between Protozoa and Metazoa, promises much of interest.

DARTMOUTH COLLEGE, *Hanover, N. H., May 25, 1899.*

NOTES ON A COLLECTION OF FISHES FROM THE RIVERS OF MEXICO, WITH DESCRIPTION OF TWENTY NEW SPECIES.

By DAVID STARR JORDAN and JOHN O. SNYDER.

INTRODUCTION.

The writers spent part of the winter of 1898–99 in Mexico, devoting their spare time to the study of the fishes in the regions visited. The collection made is not large, but it contains a surprisingly large proportion of new forms, 20 of the 42 species having not been hitherto described, a fact which indicates that the river fauna of Mexico is much richer and more characteristic than has been supposed. The specimens are in the museum of the Leland Stanford Jr. University, series more or less complete having been also sent to the United States Fish Commission, the United States National Museum, the British Museum, and the museum at Vienna. The most unexpected fact disclosed is that of the large number of very closely related species of *Chirostoma* or "pescado blanco" inhabiting the great Lake of Chapala.

We would especially acknowledge the assistance of the following gentlemen: Mr. J. E. Page and his son, for assistance in collecting near Tampico; Messrs. W. P. Mellen and W. J. Thompson, of Aguas Calientes; Mr. A. V. Temple, manager of bureau of information, Mexican Central Railroad, City of Mexico; Señor Joaquin Cuesta, of Atequiza, near Guadalajara. We are also under obligation to officials of the Mexican Central and Southern Pacific railways, and to Wells, Fargo and Company's Express.

The following is a description of the localities in which collections were made, most of the work with the seine being performed or directed by Mr. Snyder:

Rio Lerma.—The Rio Grande de Santiago, locally known as Rio Lerma, was first visited at the "Barranca" near Guadalajara, Jalisco. Here the river flows through a cañon of volcanic rock at least 2,000 feet below the surface of the surrounding tableland. The river (December 23) was swollen and muddy, the water plunging along at such a rapid rate that small seines could not be used, and no collecting was done. Rio Lerma was next examined at Ocotlan, above the great falls of Juanacatlan, near the outlet of Lake Chapala. The same high, muddy water was found, but instead of the cañon a comparatively shallow river bed which gradually spread over cornfields, marshes, and tule lands as the lake was approached. The flooded condition of the river and the consequent absence of good seining-places made collecting at the time we visited the region very unsatisfactory. To make a thorough study of the ichthyic fauna of the lake, which is a magnificent body of water, surrounded by mountains and containing several islands, one would have to be equipped with good collecting apparatus and be prepared to spend some time in the vicinity.

Rio Verde de Aguas Calientes.—At Aguas Calientes the Rio Verde, a tributary of the Lerma, which flows into Lake Chapala, was an ideal collecting-place. The clear, cool water, shaded by trees and shrubs along the banks, winds here and there over a bed of fine gravel and sand. There are ripples and shallows, frequented by smaller fishes, and many deep pools where the larger ones live.

Rio Ixtla.—At Puente de Ixtla in Morelos considerable collections were made in the Rio Ixtla, a large, clear, cold tributary of Rio Amacusac, which in turn flows into Rio de las Balsas. At this picturesque old bridge the conditions are very favorable for collections—gravelly bottom, smooth banks, and occasionally deep holes. Some specimens were taken from the small Rio Tembernbe, a "spring branch" of Rio Ixtla.

Rio Panuco.—Collecting was done in the Rio Panuco at Tampico, and in one of its tributaries, the Rio Verde, near Rascon, San Luis Potosi. At Tampico the Panuco, a very large river, receives the Rio Tamesoe. With the two, a number of large, shallow lagoons are connected. Salt tide water backs up into the rivers and lagoons for some distance above the city. The lagoons are marshy in most places, the rushes and shrubs growing out into the water for long distances. The bottom and shores are usually of a sticky blue clay, although there are sandy beaches in some localities. By visiting the Tampico markets, many specimens of the larger species were obtained.

At Rascon the Rio Verde is a rather sluggish stream. Its bottom is of gravel in some places, while in others it is muddy. Both east and west of Rascon the current of the river is very rapid, often descending the cañon in cascades and cataracts. The water, which is heavily impregnated with lime, is light green in color. On either side of the river are great forests of palms, while dense thickets of canes, ferns, and vines make it difficult to follow the shores.

List of species obtained and of the localities in which collections were made.

Species.	Rio Verde, near Aguas Calientes.	Laguna de Chapala, near Ocotlan, Jalisco.	Laguna de Chalco, near City of Mexico.	Rio Ixtla, near Puente de Ixtla, Morelos.	Rio Verde, near Rascon, San Luis Potosi.	Rio Panuco, Rio Tamesoe and lagoons near Tampico.
Lepisosteus osseus						×
tristœchus						×
Istlarius balsanus				×		
Ameiurus dugesi		×				
Ictalurus furcatus						×
Carpiodes tumidus						×
Moxostoma austrinum	×	×				
Algansea tincella	×		×			
Notropis nigrotæniatus				×		
rasconis					×	
calientis	×					
Xystrosus popoche		×				
Falcula chapalæ		×				
Hybopsis altus	×					
Tetragonopterus mexicanus				×		
argentatus					×	×
Fundulus heteroclitus						×
robustus		×				
Characodon variatus	×					
encaustus		×				
Cyprinodon elegans						×
Gambusia affinis						×
Xenendum caliente	×					
xaliscone		×				
Pœcilia limantouri				×	×	×
Mollienisia latipinna						×
Xiphophorus montezumæ					×	
Eslopsarum jordani	×					
argæ	×					
Chirostoma humboldtianum			×			
chapalæ		×				
promelas		×				
diazi		×				
crystallinum		×				
lermæ		×				
ocotlane		×				
Cichlasoma steindachneri					×	
Heros cyanoguttatus						×
istlanus				×		
Neetroplus carpintis					×	×
Philypnus dormitor						×
Awaous taiasica				×		

The following new genera are described in this paper: *Istlarius; Xystrosus; Faleula*; *Xenendum.*

The following is a list of the new species* described:

Istlarius balsanus.
Notropis rasconis.
    calientis.
Xystrosus popoche.
Falcula chapalæ.
Characodon encaustus.
Xenendum caliente.
Xenendum xaliscone.
Pœcilia limantouri.
Xiphophorus montezumæ.
Eslopsarum arge.
Chirostoma chapalæ.
    promelas.
    diazi.
Chirostoma crystallinum.
    lermæ.
    ocotlane.
Cichlasoma steindachneri.
Heros istlanus.
Nectroplus carpintis.

MEASUREMENTS.

The measurements given in the tables of this paper were made by means of a proportional scale. It is believed that they will show, in an approximately definite way, some of the variations of certain characters useful in determining the relationships of the species. They are expressed in hundredths of the length of the body, which is measured from the tip of the snout to the end of the last vertebra. The depth of the body is measured at its deepest part; depth of caudal peduncle at its narrowest place; length of caudal peduncle from base of last anal ray to end of last vertebra; length of head from tip of snout to posterior edge of opercle; length of snout from its tip to anterior margin of orbit; length of caudal fin from end of last vertebra to tip of upper caudal lobe. Only fully-developed fin rays are counted. The rudimentary rays of dorsal and anal, when closely adnate to the first branched ray, are counted with it as 1 ray. When the last ray is double and the two parts connected at the base, it is counted as 1 ray. Scales in the lateral series are counted to base of caudal fin; transverse series from insertion of ventrals or anal, whichever is nearer middle of body, upward and forward; on caudal peduncle, upward and forward at narrowest part.

LIST OF SPECIES.

LEPISOSTEIDÆ.

1. Lepisosteus osseus (Linnæus).
Plentiful in Tampico markets; said to be taken in the river and neighboring lagoons.

2. Lepisosteus tristœchus (Bloch & Schneider).
Collected in the markets of Tampico.

SILURIDÆ.

3. Ameiurus dugesi Bean.
Obtained in the markets of Guadalajara and in the Laguna de Chapala, Jalisco, Mexico.

We classify this species with the genus *Ameiurus*, believing that *Villarius* [*Villarius* Rutter, Proc. Cal. Acad. Sci., ser. 2, vol. 6, 1896, 256 (*pricei*)] is an invalid genus. *Villarius* was supposed to be distinguished by the presence of scattered villi on the skin of the sides. Such villi are, however, common to many cat-fishes, notably, *A. nebulosus*, *A. catus*, *Noturus flavus*, *Ictalurus punctatus*, *Leptops olivaris*, and *Istlarius balsanus*. Small specimens of *Ameiurus dugesi* have the caudal fins tipped with black.

4. Ictalurus furcatus (Le Sueur).
One specimen purchased in Tampico market, said to have been caught in the Rio Tamesoe.

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* These species appear at almost the same date in the fourth part of Jordan & Evermann's "Fishes of North and Middle America."

ISTLARIUS Jordan & Snyder, new genus.

Type *Istlarius balsanus* new species. Allied to *Ictalurus* and *Leptops*.

Body rather deep and compressed; head not widened nor greatly depressed; eye large; lower jaw included; teeth in villiform bands on premaxillaries and dentaries; premaxillary band convex anteriorly, with a short, angular posterior extension on each side; no division of band at symphysis; dentary band broad anteriorly, growing narrow and pointed posteriorly, with a distinct median division; no teeth on vomer or palatines; villiform teeth on upper and lower pharyngeals. Gill-rakers on first arch 17, long and slender; branchiostegals 8. Air bladder very large, extending almost to posterior end of body cavity, divided by a transverse constriction into two parts of nearly equal length, the anterior part heart-shaped, posterior part oval. Supraoccipital bone widely separated from interspinal; humeral process short, almost hidden by the skin. Lateral line extending from below insertion of dorsal to caudal; skin covered with minute hair-like villi, that of head completely concealing bones of skull. Barbels 8. Spines with distal parts soft, not branched, continuous with the hard parts; basal part of pectoral spine grooved posteriorly, weakly serrate above the groove.

Istlarius has some characters of the genus *Leptops*, notably the dentition of the upper jaw and the weakness of the fin spines, but it more closely resembles *Ictalurus*, and its relationship is probably with that genus.

5. Istlarius balsanus Jordan & Snyder, new species. *Bagre.* Fig. 2.

Type No. 6149, L. S. Jr. Univ. Mus. Locality, Rio Ixtla at Puente de Ixtla, Morelos, Mexico. Collected by Jordan & Snyder, January 3, 1899.

Head 4 in length; depth 4.66; depth of caudal peduncle 2.33 in head; eye 5.5; snout 2.4; distance between eyes 2.5; height of dorsal 1.4; length of base of dorsal 3; height of anal 1.66; length of base of anal 1; length of pectoral 1.5; ventrals 1.66; caudal 1; D. I, 6. A. 24.

Body deep and somewhat compressed, deepest part above ventrals, widest between pectorals; head narrow, not greatly depressed. Eye large, nearer to tip of snout than to posterior edge of opercle, a distance equal to diameter of eye; interorbital space convex; width of mouth, 2.5 in head; lower jaw included; upper jaw projecting a distance equal to diameter of pupil. Barbels 8; of the inferior ones, the median pair are shorter; distance between their bases equal to diameter of pupil; outer pair when extended directly backwards reaching edges of gill-covers; maxillary barbels longest, reaching upper angle of gill-opening; nostril barbels reaching middle of pupil.

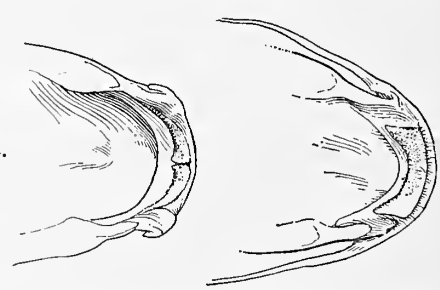
a.  b.

FIG. 1.—Views showing bands of teeth of *Istlarius balsanus.* (*a*) lower jaw, (*b*) upper jaw.

Teeth in broad villiform bands on premaxillaries and dentaries, the band on upper jaw convex anteriorly, with a short, angular posterior extension on each side; no apparent division of band at symphysis; band on lower jaw broad anteriorly, narrow and pointed posteriorly; a distinct median division; no teeth on vomer or palatines; upper pharyngeal teeth in oval, villiform bands; lower pharyngeal teeth in 2 narrow oblong bands. Gillrakers on first arch 17, long and slender. Branchiostegals 8. Anterior nostril tubular, the posterior with a raised rim extending on each side from barbel to posterior edge of opening, where it is divided.

Skin of head completely concealing bones of skull. Supraoccipital bone not in contact with first interspinal. Humeral process about as long as vertical diameter of eye, almost hidden by the thick skin. Lateral line extending from a perpendicular through insertion of dorsal to caudal; skin covered with minute, hair-like villi.

Dorsal spine with its distal third soft, preceded by a small, angular, immature spine; first and second branched rays longest, the others gradually shorter. Adipose fin large, above middle of anal; length of posterior free edge three times diameter of pupil. Fifth or sixth anal ray longest; edge of fin rounded posteriorly; caudal deeply forked, lower lobe rounded, upper rather pointed. Pectoral rays I, 11, distal two-thirds of spine soft; not branched, continuous with the hard part; basal part grooved posteriorly, weakly serrate above the groove; ventrals reaching origin of anal.

Color bluish-slate above, light-silvery below; a few small dark spots on head and body; fins with dusky coloring; inferior barbels light; maxillary barbels with upper half dark; nasal barbules with

light edges. Some specimens have many well-defined color-spots, while others have few or none. The young have no spots. Our specimens vary in length from 10 to 60 centimeters.

Istlarius balsanus has a large and rather complex air-bladder, lying close to the spinal column and extending almost to the posterior end of body cavity. It is divided by a deep, transverse construction into two halves. The anterior part is heart-shaped and constricted dorso-ventrally. It is separated by a T-shaped partition into three chambers; of these, the anterior transverse chamber is partly

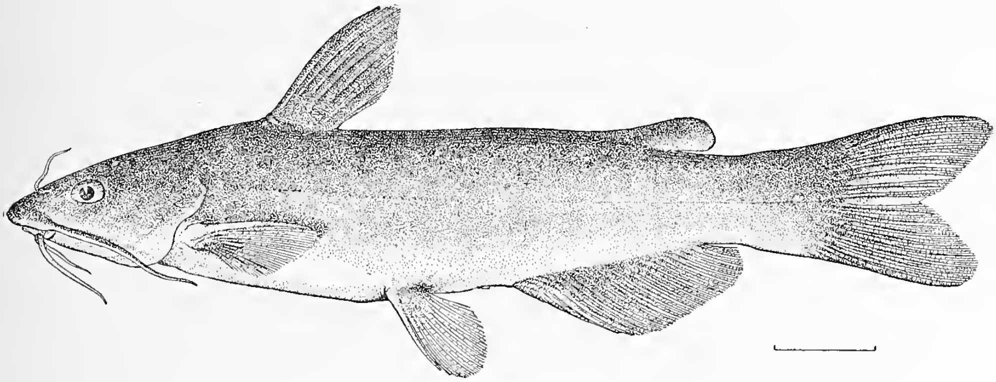


FIG. 2.—*Istlarius balsanus* Jordan & Snyder, new genus and species. Type.

divided on the median line by a fold of the dorsal wall of the bladder over the vertebral column. The transverse chamber is connected on each side with the two posterior lateral chambers by large openings in the ends of the transverse wall. The posterior half of the bladder is without partitions. It is connected with the left lateral chamber only, by a small opening.

Measurements of five specimens of Istlarius balsanus.

Measurements.	Locality: Rio Ixtla, at Puente de Ixtla, Morelos, Mexico.				
Length of body in millimeters	195	238	148	123	81
Depth of body expressed in hundredths of length	23	21	19	21	22
Depth of caudal peduncle	12	11	10	11½	12
Length of head	26	27	25	26	27
Length of snout	11	11	11	11	12
Length of maxillary barbel	21	16½	19	21	21
Longitudinal diameter of orbit	4½	5	5	5½	6
Distance from snout to dorsal	36	38	37	36	35
Height of longest dorsal rays	20	17	17	18	21
Distance from snout to adipose fin	77	81	77	79	77
Distance from snout to anal fin	66	66	64	62	65
Length of base of anal	26	26	25	27	26
Height of longest anal rays	15½	15	14	15	16
Length of caudal fin	28	25	25	26	28
Length of pectoral fin	18	16	17	17	20
Distance from snout to ventral fin	51	52½	51	49	52
Length of ventral fin	15	14	14	14	15
Number of dorsal rays	7	7	7	7	7
Number of anal rays	24	23	21	23	23

CATOSTOMIDÆ.

6. Carpiodes tumidus Baird & Girard.

Locality, lagoons near Tampico.

In the identification of these specimens, we regard *Carpiodes tumidus* Baird & Girard as a species distinct from *Carpiodes velifer* Rafinesque. The Tampico specimens agree with the description and figure of *C. tumidus* given by Baird & Girard (Baird & Girard, Proc. Ac. Nat. Sci. Phila. 1854, 28; Girard, United States and Mexico Bound. Sur., Ichthyology, 34, plate XIX, figs. 1–4). They all have the first rays of the dorsal short; in most cases the tip of the fin is rounded—in striking contrast to the very long rays and the scythe-shaped fin of *C. velifer* of the Mississippi Valley.

Measurements of five specimens of Carpiodes tumidus.

Measurements.	Collected in markets of Tampico, Mexico.				
Length of body in millimeters	245	265	242	256	210
Depth of body expressed in hundredths of length	44	42	40	42	42
Depth of caudal peduncle	16½	16	15	16	16
Length of head	26½	26	25	26	26
Width of interorbital space	12½	13	13	13	13
Length of snout	9½	9	8	9	8
Diameter of orbit	5	5	5	5	6
Distance from snout to dorsal	57½	55	54½	58	56½
Height of longest dorsal rays	24	21	27	25	27
Distance from snout to anal fin	82½	82	82½	82	84
Height of longest anal rays	21	22	20	20	27
Distance from anal to caudal	13	13	12	12	13
Length of caudal fin	31	29	32	30	35
Length of pectoral fin	19	20	21	19	22
Distance from snout to ventral	52	51	52	51	52½
Length of ventral	20	21	20	22	25
Number of rays in dorsal fin	25	26	24	25	23
Number of rays in anal fin	8	9	8	8	8
Number of scales in lateral line	35	36	34	35	36
Number of scales above lateral line	7	7	8	8	8
Number of scales before dorsal	14	16	14	15	16

7. Moxostoma austrinum Bean.

Obtained from the Rio Verde, Aguas Calientes, and Rio Grande de Santiago, near Atequiza, Jalisco. Numerous specimens, about 170 millimeters in length, were taken in the Rio Verde. A large specimen from the Rio Grande de Santiago was presented to the Museum by Señor Joaquin Cuesta.

Some fin-ray and scale counts of the Rio Verde specimens are here given:

Measurements.	Locality: Rio Verde.											
Number of dorsal rays	11	11	11	10	11	10	11	11	11	11	11	11
Number of anal rays	7	7	7	7	7	7	7	7	7	7	7	7
Number of scales in lateral line	48	48	47	46	47	45	46	47	46	47	48	48
Number of scales in transverse series	16	15	16	15	14	15	15	15	15	15	15	14

CYPRINIDÆ.

8. Algansea tincella (Cuvier & Valenciennes).

Locality: City of Mexico market, said to have come from Lago de Chalco; Rio Verde, at Aguas Calientes.

Measurements of ten specimens of Algansea tincella.

Measurements.	Locality: Rio Verde, Aguas Calientes.									
Length of body in millimeters	96	109	94	103	94	102	95	87	85	82
Depth of body expressed in hundredths of length	26	23	26	25	25	25	25	26	27	27
Depth of caudal peduncle	12½	12	13½	13	14	12½	12½	13	13	13
Length of head	25	24	25	25	25	25	26	25	24	25
Distance from snout to occiput	20	19	20	20	20	20	20	20	21	21
Width of interorbital space	9	8	8½	9	8	8½	9	9	9	8½
Length of snout	7	7½	7	7½	7	7	7½	7	7	7½
Length of maxillary	6½	7	7	7½	7	7	7	7	6	7
Diameter of orbit	4	4½	5	5	5	4	5	4	5½	5
Distance from snout to dorsal fin	54	53	52	55	52	53½	54	52	52	52
Height of longest dorsal rays	20	17	19	19	20	17	17	20	19	20
Distance from snout to anal fin	75	76	72	76	73	75	74	75	74	74
Height of longest anal rays	15	14	16	16	15	15	15	16	14	15
Distance from anal to caudal fin	21	20	21	19	22	20	20	21	21	22
Length of caudal fin	23	22	22	24	23	22	23	24	23	23
Length of pectoral fin	16	16	16	18	21	17	17	20	17	20
Distance from snout to ventral fin	55	53	53	55	51	52	52	52	53	54
Length of ventral fin	14	12½	14	14	15	13	14	16	13	15
Number of rays in dorsal fin	8	8	8	8	8	8	8	8	8	8
Number of rays in anal fin	7	7	7	7	7	7	7	7	7	7
Number of rays in pectoral fin	15	16	16	16	15	16	15	16	16	16
Number of scales before insertion of dorsal	30	29	31	28	27	27	30	29	30	31
Number of scales between dorsal and lateral line	16	15	16	15	16	17	16	16	16	16
Number of scales in lateral line	68	64	75	70	70	67	64	69	74	......

We have one specimen of *Algansea tincella* from Lago de Chalco. It is not distinguishable, except in its darker color, from those taken in the Rio Verde. These differ from the description and figure of *A. dugesi* (Bean, Proc. U. S. Nat. Mus., 1892, 283) in having much smaller eyes and a deeper caudal peduncle. They have a distinct black spot at the base of the caudal. The specimens taken in the Rio Lerma, at Salamanca, by Professor Woolman, and recorded as *A. dugesi* (Woolman, Bull. U. S. F. C. 1894, 61), agree in every respect with those from the Rio Verde and are referred by us to the same species. Some of Mr. Woolman's specimens are in the museum of Stanford University.

9. **Notropis nigrotæniatus** (Günther).

Graodus nigrotæniatus Günther. Cat., VII, 485, 1868, Atlisco, Mexico.

Locality, Rio Ixtla at Puente de Ixtla, Morelos.

As shown by our specimens, *N. nigrotæniatus* differs from the closely related species, *N. rasconis* of the Rio Panuco system, in having a thicker and heavier body, a shorter snout, smaller eyes, shorter and more rounded fins, a wider lateral band, the black dots of which are distributed over a space about the width of two scales, a less distinct caudal spot, and the color-band not definite on the snout.

Measurements of two specimens of Notropis nigrotæniatus.

Measurements.	Locality: Rio Ixtla.	
Length of body in millimeters	51	60
Depth of body expressed in hundredths of length	26	26
Depth of caudal peduncle	12	11
Length of head	23	23
Distance from snout to occiput	20	20
Width of interorbital space	8	8
Length of snout	7	7½
Diameter of orbit	6½	6
Distance from snout to dorsal fin	51	52
Height of longest dorsal rays	21	21
Distance from snout to anal fin	67	66
Height of longest anal rays	16	17
Distance from anal to caudal fin	35	33
Length of caudal fin	25	25
Length of pectoral fin	20	19
Distance from snout to ventral fin	47	48
Length of ventral fin	16	16
Number of rays in dorsal fin	8	8
Number of rays in anal fin	9	8
Number of rays in pectoral fin	12	12
Number of scales before insertion of dorsal fin	14	15
Number of scales in lateral line	38	36

10. **Notropis rasconis** Jordan & Snyder, new species. Fig. 3.

Type specimen No. 6153, L. S. jr. Univ. Mus.

Three specimens belonging to the genus *Notropis*, which resemble very closely *N. nigrotæniatus* of the Rio de las Balsas system, were collected in the Rio Verde, near Rascon, January 25, 1899, by J. O. Snyder. They differ from that species, however, in having a more compressed body, a longer snout, larger eyes, longer and more pointed fins, and in having the color-band narrower on the body and more marked on the snout.

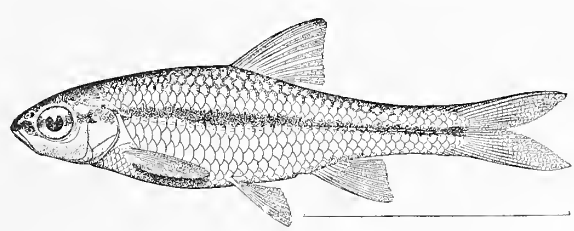


FIG. 3.—*Notropis rasconis* Jordan & Snyder, new species. Type.

Head 4 in length; depth 3.50; eye 2.66 in head; snout 3.33; interorbital space 3; depth of caudal peduncle 2.25; height of dorsal 4.33 in length; anal 5.20; length of pectoral 5.5; ventral 5.5; caudal 3.5; number of scales in lateral line 33; between dorsal and occiput 15; between dorsal and ventral fins 10. D. I, 8. A. I, 8. P. 12.

Dorsal outline of body evenly rounded from snout to insertion of dorsal fin, slightly concaved from latter point to base of caudal; ventral outline evenly rounded to end of anal base; deepest part of body just anterior to insertion of dorsal; width of body one-seventh of its length. Snout pointed, mouth oblique, lower jaw included; maxillary not quite reaching vertical from anterior margin of orbit. Teeth 4–4, frail and easily detached from the arch; slightly hooked; no evident grinding surface. Gillrakers short and blunt, reduced to slight elevations on lower part of first arch.

First fully developed ray of dorsal fin longest, last ray much shorter. When the fin is elevated the posterior margin is straight; when depressed it is somewhat falcate. Anal fin similar in shape. Pectorals pointed. Tips of ventrals reaching anal. Caudal deeply forked, the lobes pointed.

Color silvery; a dark lateral band, the width of a scale, extending from tip of snout, through eye to base of caudal, where it ends in an elongate black spot; body above lateral band stippled with black; the dots grouped closely together on top of head and in a narrow dorsal band extending from occiput to insertion of dorsal, in a sharply defined black line along base of dorsal fin, and also on edges of dorsal scales. Body below dark band immaculate except a dusky line along base of anal fin. All of the fin rays dusky, especially the partly developed caudal rays, which are noticeably darker than the others.

Measurements of three specimens of Notropis rasconis.

Measurements.	Locality: Rio Verde, near Rascon.		
Length of body in millimeters	43	44	43
Depth of body expressed in hundredths of length	28	27½	24
Depth of caudal peduncle	11	11	11
Length of head	26	26	25
Distance from snout to occiput	23	23	24
Width of interorbital space	8	8	8
Length of snout	8	7½	8
Diameter of orbit	8½	8	8
Distance from snout to dorsal fin	55	54	52
Height of longest dorsal rays	23	24	24
Distance from snout to anal fin	69	69	68
Height of longest anal rays	21	19	19
Distance from anal to caudal fin	33	32	36
Length of caudal fin	29	29	30
Length of pectoral fin	20	20	21
Distance from snout to ventral fin	51	52	51
Length of ventral fin	17	17½	18
Number of rays in dorsal fin	8	8	8
Number of rays in anal fin	8	8	8
Number of rays in pectoral fin	12	12	12
Number of scales before insertion of dorsal fin	15	15	15
Number of scales in lateral line	33	34	34

11. Notropis calientis Jordan & Snyder, new species. Fig. 4.

Type No. 6193, L. S. jr. Univ. Mus.

Collected in the Rio Verde, at Aguas Calientes, on January 9, 1899, by J. O. Snyder.

Head 3.66 in length; depth 3.33; eye 4 in head; snout 4; interorbital space 2.66; depth of caudal peduncle 2.40; height of dorsal 4.66 in length; anal 5.75; length of pectoral 5.66; ventral 6; caudal 3.83; scales in lateral line 33; between dorsal and occiput 15; between dorsal and ventral fins 10. D. 8. A. 7.

Body deep and wide, deepest part anterior to insertion of dorsal; caudal peduncle long and slender; snout blunt, rounded; mouth oblique; jaws equal; maxillary reaching to a vertical from posterior nostril. Teeth 4-4, slender, hooked, grinding surface narrow, absent on smallest tooth. Gillrakers short, blunt; 9 on first arch. Intestinal canal short, with but 1 convolution; peritoneum white, scales large, not notably deeper than long. Lateral line incomplete, extending only as far as posterior edge of pectoral. Dorsal fin rounded, the second, third, and fourth rays longest. Anal fin similar in shape; ventrals rounded, extending to vent; inserted directly under dorsal. Pectorals rounded. Caudal forked, the lobes rounded.

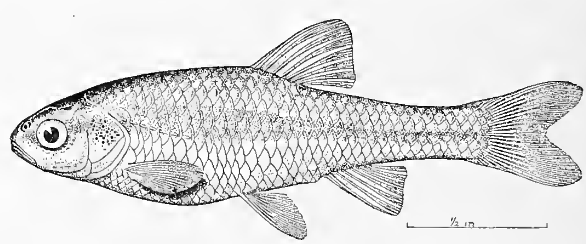


Fig. 4.—*Notropis calientis* Jordan & Snyder, new species. Type.

Color silvery, an indefinite dark band extending from tip of snout to end of caudal peduncle; the band distinct on snout and caudal peduncle; broader and almost obsolete on middle of body; top of head and a narrow band on median dorsal part of body dark; ventral parts of body immaculate, except a narrow, dark band extending along base of anal and ventral part of caudal peduncle; chin white; scales on upper parts, with dark edges; dorsal and caudal fins slightly dusky; other fins lighter.

This species is of small size, the mature males measuring about 34 mm. in length of body; the females 43. The males are more slender and have a little less dark color on the body. The affinities of

Notropis calientis are with *Notropis cayuga*, *N. jordani*, and others of the subgenus *Chriope*. The species may be distinguished by its small eye, the short, rounded snout, deep body, short lateral line, and rounded fins.

Measurements of ten specimens of Notropis calientis.

Measurements.	Locality: Rio Verde, Aguas Calientes, Mexico.									
Length of body in millimeters	42	44	42	41	40	38	36	36	34	32
Depth of body expressed in hundredths of length	28	29	29	28	30	29	30	26	26	26
Depth of caudal peduncle	10	10	10	11	12	10	10	12	10	10
Length of head	26	25	26	27	27	25	25	26	26	27
Distance from snout to occiput	20	21	19	21	20	20	20	20	21	20
Width of interorbital space	10	8	10	10	10	9	10	10	9	10
Length of snout	7	7	7½	7	7	7½	7	7	8	7
Diameter of orbit	7	7	7	7	7	6½	6½	6	7	7
Distance from snout to dorsal fin	53	53	52	54	53	52	52	51	55	52
Height of longest dorsal rays	20	22	20	22	22	22	21	23	21	23
Distance from snout to anal fin	67	70	69	69	70	70	70	68	68	68
Height of longest anal rays	18	16	17	18	17	17	17	19	19	18
Distance from anal to caudal fin	24	24	24	24	23	23	25	25	23	26
Length of caudal fin	24	22	25	26	26	20	25	24	25	23
Length of pectoral fin	18	16	16	17	18	18	17	20	17	17
Distance from snout to ventral fin	52	52	53	53	56	53	51	53	50	52
Length of ventral fin	18	16	15	17	16	17	17	16	15	16
Number of rays in dorsal fin	8	8	8	8	8	8	8	8	8	8
Number of rays in anal fin	7	8	7	7	7	7	7	7	7	7
Number of scales before insertion of dorsal	14	16	15	14	15	17	16	17	17	16
Number of scales in lateral line	33	34	32	35	35	36	35	34	36	34

XYSTROSUS Jordan & Snyder, new genus.

Type, *Xystrosus popoche*, new species. Body long, compressed; interorbital space low and flat; mouth terminal, oblique; jaws subequal; premaxillary protractile. No barbel. No pseudobranchiæ. Gillrakers 66, long, slender, crowded on arch. Teeth 4–4, hooked, grinding surface oblique, grooved.

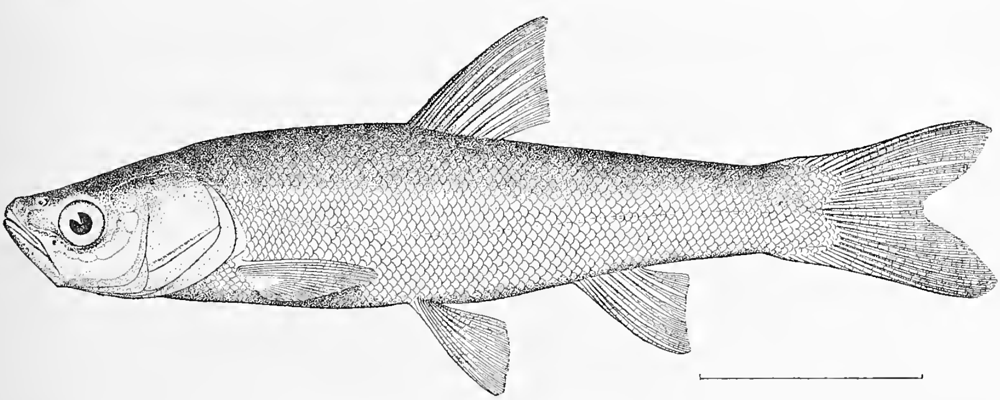


FIG. 5.—*Xystrosus popoche* Jordan & Snyder, new genus and species. Type.

Alimentary canal about twice as long as body. Peritoneum dusky. Lateral line complete, decurved above pectorals. Scales 61, evenly distributed over body. Fins falcate; dorsal inserted directly above insertion of ventral; caudal deeply forked; anal basis short.

The genus *Xystrosus* is allied to *Notropis*, differing in the long gillrakers, the small scales, and the absence of pseudobranchiæ.

12. Xystrosus popoche Jordan & Snyder, new species. *Popoche*. Fig. 5.

Type No. 6151, L. S. Jr. Univ. Mus. Locality, Laguna de Chapala, near Ocotlan, Jalisco, Mexico. Collected by J. O. Snyder, December 26, 1898.

Head 3.5 in length; depth 4.5; eye 4.66 in head; snout 3.60; interorbital space 2.60; depth of caudal peduncle 2.5; height of dorsal 5 in length; anal 6; length of pectoral 6; ventral 6.25; caudal 4. D. 8. A. 7. Number of scales in lateral line 61; between dorsal and occiput 24; between dorsal and lateral line 16; number of dorsal rays 8; anal 7; pectoral 16.

Body long and slender; caudal peduncle deep, compressed; head long, its upper contour slightly concave; interorbital space broad and flat; eye large, its longitudinal diameter contained 2 times in interorbital space; snout sharp, slightly turned up at end; mouth large, oblique; lips thin,

maxillary not quite extending to orbit. Gillrakers 66 on first arch, close together, slender, the length of longest half diameter of orbit. Teeth 4–4, strong, hooked, grinding surface oblique, narrow, grooved; a notch just below the hook. Alimentary canal almost twice length of body. Peritoneum dusky.

Scales not crowded anteriorly, evenly distributed over the body; lateral line shaped like the ventral contour of body, except above pectoral fins, where it is sharply decurved. Dorsal inserted directly above ventral, first ray highest, nearly three times height of last; when depressed the fin is falcate; when elevated, its edge is concave; anal similar in shape; caudal deeply forked, the tips sharp; ventrals pointed, not reaching vent; pectorals slightly rounded.

Color silvery, darker above, especially on median dorsal area, where a more or less definite dusky band extends the length of body; rays of dorsal fin and tips of caudal dusky; lower fins white.

Exact measurements of the only specimen obtained are here given. Length of body in 92 mm.; depth of body expressed in hundredths of length 23; depth of caudal peduncle 11½; length of head 28½; width of interorbital space 11½; length of snout 8; diameter of orbit 6; distance from snout to dorsal fin 52; height of longest dorsal rays 20; distance from snout to anal fin 73; height of longest anal rays 17; distance from anal to caudal fin 21; length of caudal fin 25; length of pectoral fin 18; distance from snout to ventral fin 53; length of ventral fin 16.

FALCULA Jordan & Snyder, new genus.

Type, *Falcula chapalæ* new species. Body long, compressed; caudal peduncle slender; mouth large; lips thin; premaxillary protractile. No barbel. Teeth in 1 row, 4–4, hooked; grinding surface grooved. Gillrakers few, short, far apart. Alimentary canal short. Peritoneum silvery. Lateral

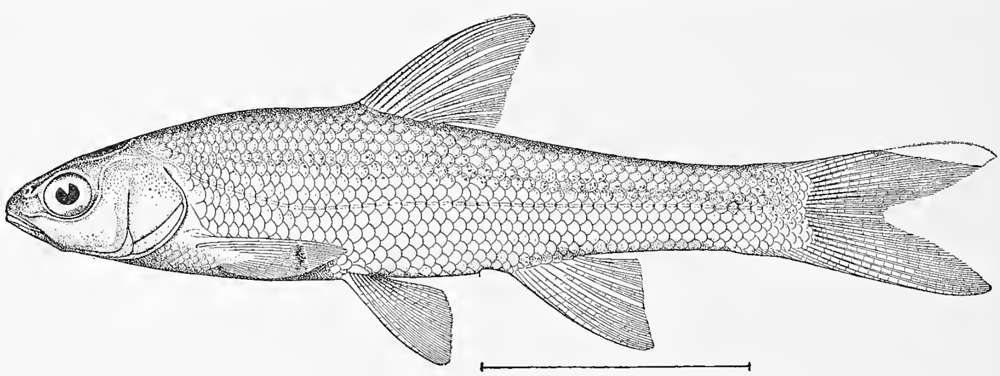


FIG. 6.—*Falcula chapalæ* Jordan & Snyder, new genus and species. Type.

line complete. Scales rather small, about 50 in lateral series. Fins high, falcate; dorsal inserted directly over ventrals; anal basis short; first simple rays of dorsal and anal rudimentary and closely adnate to first branched ray, caudal long, deeply notched.

The genus *Falcula* is related to *Notropis*, from which it differs in its small scales and in its very high, falcate fins.

13. Falcula chapalæ Jordan & Snyder, new species. Fig. 6.

Type No. 6152, L. S. Jr. Univ. Mus. Collected by J. O. Snyder, at Laguna de Chapala, near Ocotlan, Jalisco, Mexico, December 26, 1898.

Head 4 in length; depth 4.50; eye 3.66 in head; snout 3.66; interorbital space 3.66; depth of caudal peduncle 9.5 in length; height of dorsal 4; anal 5; length of pectoral 4.80; ventral 5.75; caudal 3.25; number of scales in lateral line 50; between dorsal and occiput 19; between dorsal and ventral fins 16. D. 8. A. 8. P. 17.

Body long, slender, compressed; snout pointed; its length equal to diameter of orbit or to interorbital space; mouth almost horizontal, its cleft extending to a vertical from anterior edge of orbit; lips thin. Teeth 4–4, strong, slightly hooked, the hook barely evident on lower tooth; three upper teeth with a grooved grinding surface. Gillrakers 3+7, short, pyramidal, and far apart. Alimentary canal short. Peritoneum silvery. Lateral line complete, decurved to a point in a vertical midway between pectoral and ventral fins, whence it extends in a straight line a little below middle of body to caudal. Fins all very high and pointed; dorsal inserted directly over origin of ventrals, falcate when depressed, its second ray longest; anal similar in shape; inserted at a point two-thirds the distance

from tip of snout to base of caudal; ventrals extending to vent; tips of pectorals reaching ventrals; caudal deeply forked.

Color silvery; a narrow, dark median band extending from occiput to base of caudal; dorsal scales with fine dots which give their edges a dusky color.

One specimen was taken, careful measurements of which are given. Length of body in millimeters 74; depth of body expressed in hundredths of length 25; depth of caudal peduncle 11; length of head 25; width of interorbital space 7; length of snout 7; diameter of orbit 7; distance from snout to dorsal fin 47; height of longest dorsal rays 26; distance from snout to anal fin 67; height of longest anal rays 21; distance from anal to caudal fin 27; length of caudal fin 31½; length of pectoral fin 22; distance from snout to ventral fin 62; length of ventral fin 21.

14. Hybopsis altus (Jordan).

Many specimens from the Rio Verde, Aguas Calientes, some of which were 165 millimeters long.

CHARACINIDÆ.

15. Tetragonopterus mexicanus Filippi.

Specimens of *Tetragonopterus* caught in the Rio Ixtla at Puente de Ixtla, Morelos, resemble very closely those taken in the Rio Verde near Rascon, but we believe that they belong to a different species. Besides the points of difference expressed in the following table, *T. mexicanus* of the Rio Ixtla has smaller and weaker teeth than *T. argentatus* of the Rio Verde.

Average measurements of ten specimens each of Tetragonopterus mexicanus from the Rio Ixtla and of Tetragonopterus argentatus from the Rio Verde near Rascon.

Measurements.	Tetragonopterus mexicanus.	Tetragonopterus argentatus.
Length of head expressed in hundredths of length	25. 10	28. 75
Distance from snout to occiput	25. 25	28. 25
Distance from lower jaw to occiput	26. 50	28. 80
Width of interorbital space	8. 80	9. 70
Length of snout	6. 60	7. 09
Diameter of orbit	8. 40	10. 10
Distance from snout to origin of dorsal fin	51. 25	54. 30

Measurements of ten specimens of Tetragonopterus mexicanus.

Measurements.	Locality: Rio Ixtla at Puente de Ixtla, Morelos, Mexico.									
Length of body in millimeters	48	55	59	52	51	75	79	79	88	94
Depth of body expressed in hundredths of length	35	34	38	35	36	35	34	38	37	39
Depth of caudal peduncle	12	12	12½	12½	12	12	12	12½	13	12¼
Length of head	25	24	26	26	26	24	24	26	25	25
Distance from snout to occiput	26	25	26½	27	26	24½	24	23½	26	24
Tip of lower jaw to occiput	27	26	27	28	27	26	26	25½	27	25½
Width of interorbital space	9	8	9	8½	9	8½	8½	9	9½	9
Length of snout	6	6	7	7½	7	6	6	7	6½	7
Diameter of orbit	9	8½	8½	9	9	8	8	8	8	8
Distance from snout to dorsal	54	52½	52½	50	51½	50	52	52	53	50
Insertion of dorsal to adipose fin	35	36½	37½	37	37	35	38	37½	35	36
Height of longest dorsal rays	25	25	26	26	26	21	23	22	24	23
Distance from snout to anal fin	69	65	68	63	64	66	67	69	67	66½
Height of longest anal rays	15	15	16½	17	16	13	15	13	15	14
Distance from anal to caudal fin	14	15	15	15	15	16½	14	15	15	16
Length of caudal fin	25	27½	33	31	30	27	28	28	30	28
Length of pectoral fin	23	21	25	22½	24	20	20	21	22	21
Distance from snout to ventral fin	49	48	50	47	51	48½	49	52	50	51
Length of ventral fin	16	16	18	18	17	15	16	15	17	15½
Number of dorsal rays	10	10	10	10	10	9	10	10	9	9
Number of anal rays	22	23	21	21	23	21	23	21	20	23
Number of pectoral rays	14	14	14	13	12	13	13	13	14	13
Number of scales in transverse series	15	14	15	14	14	14	14	15	15	15
Number of scales in lateral line	36	35	33	33	33	33	37	36	34	36

16. Tetragonopterus argentatus (Baird & Girard).

The specimens of *T. argentatus* from the Rio Verde near Rascon were not more than 55 mm. long. The ventral and anal fins were dashed with a bright orange-red and the caudal was tipped with orange. A few specimens from the Rio Tamesoe were like those from the Rio Verde, except that the fins were not colored.

Measurements of ten specimens of Tetragonopterus argentatus.

Measurements.	Locality: Rio Verde at Rascon.									
Length of body in millimeters	55	47	44	47	43	42	40	38	37	37
Depth of body expressed in hundredths of length	35	35	36	34	34	33	34	34	35	34
Depth of caudal peduncle	12	12	12	11	12	12	12	12	12	12
Length of head	29	29	29	27½	27	29	29	28	30	30
Distance from snout to occiput	28	28	28	27½	27	28	28	29	30	29
Tip of lower jaw to occiput	28	28½	29	27½	28	29	29	29	30	30
Width of interorbital space	9	10	10	10	9	10	10	9	10	10
Length of snout	8	8	8	8	8	8	8	8	8	7½
Diameter of orbit	10	10	10	10	9	10	10	10	11	11
Distance from snout to dorsal fin	56	53	54	54	52	53	55	58	54	54
Insertion of dorsal to adipose fin	33	36	37	36	36½	36	37	35	38	33
Height of longest dorsal rays	23	22½	23½	22	22	22	22	22	24	24
Distance from snout to anal fin	68	69	69	64	67	69	69	69	68	68
Height of longest anal rays	15	15	16½	16½	16	16	15	15	16	15
Distance from anal to caudal fin	15	15	16	15	14	16	14	15	15	14
Length of caudal fin	27	26	28	28	27	29	29	28	28	25
Length of pectoral fin	21	20	21	22	21	20	19	22	19	22
Distance from snout to ventral fin	51	53	54	50	50	52	51	52	48	53
Length of ventral fin	15	14	13	15	15	14	13	15	15	15
Number of dorsal rays	10	9	9	9	9	9	9	9	10	9
Number of anal rays	21	20	20	21	20	20	20	20	20	19
Number of pectoral rays	13	12	13	12	13	12	12	12	12	12
Number of scales in transverse series	15	15	14	13	13	14	14	14	14	13
Number of scales in lateral line	37	33	34	31	34	31	31	34	30	34

PŒCILIIDÆ.

17. Fundulus heteroclitus (Linnæus). Lagoons near Tampico.

18. Fundulus robustus Bean. Mouth of Laguna de Chapala, Jalisco.

19. Characodon variatus Bean. Rio Verde, Aguas Calientes.

The large males have no dark spots. The dark, lateral color-band is very marked. In life there was a terminal band of bright orange-yellow on the caudal, and also a washing of the same color on the lower parts of the body posterior to the ventrals. In the small males the lateral dark band is more or less broken up into spots. There are spots on other parts of the body, generally arranged in a row on the lower parts posterior to ventral fins; terminal caudal band usually absent. The large females are similar in color to the small males. The small females are more spotted.

20. Characodon encaustus Jordan & Snyder. New species. Fig. 7.

Type No. 6163, L. S. Jr. Univ. Mus. Locality, Laguna de Chapala, near Ocotlan, Jalisco, Mexico. Collected by J. O. Snyder, December 26, 1898.

Head 3.80 in length; depth 3.66; depth of caudal peduncle 8; eye 3 in head; snout 4; interorbital space 3.5; height of dorsal 4.5 in length; anal 6.5; length of pectoral 5.33; ventral 6.5; caudal 4.33. D. 16. A. 16. Scales in lateral series 35; transverse series counting upward and forward from origin of anal 13; on caudal peduncle 9.

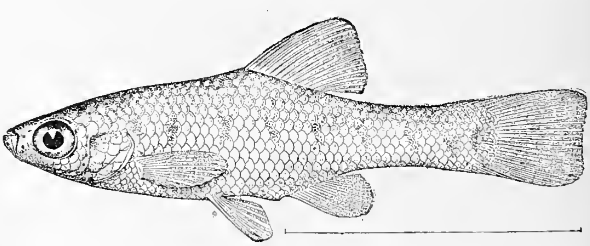


Fig. 7.—*Characodon encaustus* Jordan & Snyder, new species. Type.

Body deep, compressed; dorsal outline almost straight from snout to origin of dorsal, concave from the latter point to base of caudal; ventral outline evenly curved from snout to posterior part of base of anal. Eye very large, located nearer to snout than to posterior edge of opercle a distance equal to longitudinal diameter of pupil. Mouth small, its width equal to two-thirds diameter of pupil; maxillary protractile; lower jaw projecting. Teeth in 2 series, outer series small, bicuspid, in single row, rather firmly attached; inner series minute, in small patches. Gill-openings restricted, not extending above base of pectoral. Gillrakers slender, equal in length to half the diameter of pupil. Alimentary canal short. Air-bladder large, extending posteriorly to a point above origin of anal. Dorsal fin inserted halfway between tip of snout and base of caudal; length of base a little less than height of fin; anal inserted below middle of dorsal, its edge rounded; pectorals extending beyond bases of ventrals; ventrals extending to vent. Scales on body large; upper posterior part of head and a narrow space below and posterior to eye with scales; other parts of head naked; small scales on basal part of caudal fin. A row of large pores above eye and at lower edge of suborbital patch of scales. No lateral line.

Color in alcohol, light yellowish-olive; 9 short and narrow dark vertical bands on median part of body; the first above base of pectoral; the ninth at base of caudal; scales on dorsal region of body edged with black dots; upper part of head dark; upper half of orbit black; opercles silvery; dorsal fin with a little dusky; other fins without dark color.

Characodon encaustus somewhat resembles *C. eiseni* in appearance. It differs in having more rays in the dorsal and anal fins, smaller scales, a more compressed body, and less dark color on the body. One female specimen only was collected.

21. Cyprinodon elegans Baird & Girard.

Three small female specimens of *Cyprinodon* from lagoons near Tampico are, with some doubt, referred to the species *elegans*.

22. Gambusia affinis Baird & Girard.

A number of males and females of *Gambusia affinis* were collected in lagoons near Tampico, and especially in small pools left by high water.

XENENDUM Jordan & Snyder, new genus.

Type, *Xenendum caliente*, new species.

Body deep, not much compressed. Males and females of about the same size. Eye normal. Mouth vertical, lower jaw projecting. Teeth loosely attached, in 2 series; first series flat, bicuspid, in 2 or 3 rows on each jaw; second series minute, in villiform bands, sometimes absent. Gill-openings not restricted, extending above the pectoral fin a distance equal to diameter of pupil. Alimentary canal long, with many convolutions. Air-bladder present, large. Scales large. No lateral line. Dorsal and anal inserted posteriorly, the one directly over the other, their bases short; anal very

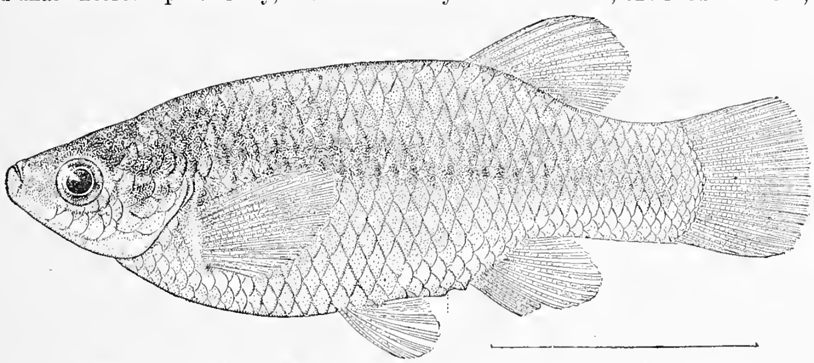


FIG. 8.—*Xenendum caliente* Jordan & Snyder, new genus and species. Type.

slightly modified in male, first rays shorter; edge of fin double convex—the notch being between the smaller and larger groups of rays. Ventral fins present. Caudal rounded, and not modified in male.

Xenendum differs notably from *Characodon* in having the bicuspid teeth loosely attached and in more than one series. *Characodon* has the bicuspid teeth firmly attached and in a single series. The actual affinities of *Xenendum* are with the genus *Goodea*, and it belongs to the subfamily *Goodeinæ*, which has the general characters of the *Pœciliinæ*, but with bifurcate or trifurcate teeth and no great differences between the sexes. *Characodon luitpoldi* Steindachner seems to be a species of *Xenendum*.

23. Xenendum caliente Jordan & Snyder, new species. Fig. 8.

One male specimen, type No. 6147, L. S. Jr. Univ. Mus., from Rio Verde near Aguas Calientes, Mexico. Collected by J. O. Snyder, January 9, 1899.

Head 3.75 in length; depth 2.60; depth of caudal peduncle 5.66; eye 4 in head; snout 3.20; interorbital space 2; height of dorsal 5.66 in length; anal 6.75; length of pectoral 5; ventral 7.66; caudal 5. D. 13. A. 14. Scales in lateral series 36; transverse series counting upward and forward from origin of anal 14; on caudal peduncle 9.

Body large and thickset, deepest part at tip of pectoral; width contained $4\frac{2}{3}$ times in length; head pointed; interorbital space broad; slightly convex; length of snout about equal to diameter of orbit; mouth vertical, its width equal to length of snout; maxillary very protractile. Teeth loosely attached in 2 series, those of first series larger, flat, and notched, in 2 rows on upper jaw, 3 rows on lower, the individual teeth of each row alternating in position with those of the next; those of second series very minute in a villiform band. Gill-openings not restricted, extending above the pectoral a distance equal to diameter of pupil. Gillrakers long, slender, and close together, 40 on first arch.

Alimentary canal long (in another specimen, 4½ times length of body), coiled many times. Peritoneum black. Genital opening close to basis of anal, covered by a thick, notched pad. Dorsal fin inserted posteriorly, rounded; its basis short, its length less than height of fin; anal inserted under dorsal, first 5 rays crowded together and shortened, edge of fin double convex—the notch being between the shorter and longer sets of rays; pectorals and ventrals with rounded edges; caudal evenly rounded. Body and head everywhere except jaws and preorbital area with scales; no lateral line.

Color light-olive, growing darker above; median dorsal area blackish, each scale with a dark, angular band, those of the sixth series below the dorsal darker, making an indistinct, narrow lateral band; all the fins except ventrals dusky.

The females differ but slightly from the males. The body of the former is more thickset, the caudal peduncle a little less deep, the fins a little lower, and the anal evenly rounded. The young are somewhat mottled in color.

Xenendum caliente differs from *X. luitpoldii* Steindachner, in having fewer scales in the lateral and transverse series and on the caudal peduncle, and in a similar way from *X. xaliscone*, besides having villiform teeth, which are absent in *X. xaliscone*.

Measurements of ten specimens of Xenendum caliente.

Measurements.	Locality: Rio Verde, Aguas Calientes, Mexico.									
	Male.					Female.				
Length of body in millimeters	63	71	67	63	48	72	71	73	73	45
Depth of body expressed in hundredths of length	37	34	35	36	37	40	34	33	34	35
Depth of caudal peduncle	18	17	17	17	17	16	16	17	16	16
Length of head	27	26	26	25	27	25	25	25	24	26
Width of interorbital space	13	13	13	13	13	14	13	13	13	13
Length of snout	9	9	9	9	9	9	9	8	9	8
Width of mouth	9	9	9	9½	9½	8½	8½	9	8	9
Diameter of orbit	6	6	6	7	7½	6	6½	6	6	7½
Distance from snout to dorsal fin	72	70	70	71	72	74½	72	70	73	73
Height of longest dorsal rays	19	18½	19	19	18	17	14	16	16	15
Distance from snout to anal fin	72	72	71½	70	72	72	69	69	70	71
Height of longest anal rays	15	14	14	14	13	12	12½	13	12	15
Distance from anal to caudal fin	23	24	24	24	25	23	24	24	24	26
Length of caudal fin	22	20	20	21	20	21	19	20	19	19
Length of pectoral fin	20	20	20	20	20	19	19	18	13	18
Distance from snout to ventral fin	54	51	53	54	53	53	51½	51	53	53
Length of ventral fin	13	14	13	13	13	12	13	13	13	14
Number of rays in dorsal	13	12	14	13	12	13	13	13	13	13
Number of rays in anal	14	14	14	14	14	14	13	14	14	13
Number of scales in lateral series	36	37	37	37	35	38	37	38	38	38
Number of scales in transverse series	14	13	13	13	14	14	14	13	14	14
Number of scales on caudal peduncle	9	9	9	9	9	9	9	9	10	9

24. Xenendum xaliscone Jordan & Snyder, new species. Fig. 9.

Type, a female, No. 6148, L. S. Jr. Univ. Mus. Locality, Laguna de Chapala, near Ocotlan, Jalisco, Mexico. Date, December 26, 1898. Collector, J. O. Snyder.

Head 4.66 in length; depth 3.33; depth of caudal peduncle 6.5; eye 3.80 in head; snout 3; interorbital space 1.66; height of dorsal 6.50 in length; anal 9; length of pectoral 5.25; ventral 7.50; caudal 5. D. I, 13. A. I, 14. Scales in lateral series 42, transverse series, counting upward and forward from origin of anal, 17; on caudal peduncle, 12.

Body thickset, deepest at origin of ventrals, widest at bases of pectorals; caudal peduncle deep and long. Head large and pointed; interorbital space broad, slightly convex; mouth vertical, its width equal to length of snout; maxillary very protractile. Teeth loosely attached, broader at distal ends than at bases, bicuspid, in two rows on each jaw; no villiform teeth present. Gill-openings extending above base of pectorals a distance about equal to diameter of pupil. Gillrakers long, flat, very close together, 56 on first arch. Alimentary canal long, in many folds. Peritoneum black.

Dorsal fin inserted posteriorly, first ray simple, closely attached to second; edge of fin rounded. Anal inserted on a vertical passing through base of fourth dorsal ray, similar to dorsal in shape; pectoral and ventral fins rounded; edge of caudal a little convex, basal one-fourth with scales. Scales large, everywhere on body and head except lower jaw and preorbital area; no lateral line.

Color plain, dark above, light below, the dark color leaving off rather abruptly on the head along a line passing through lower edge of eye; on the body, along a line passing from lower edge of base of pectoral to caudal, leaving lower one-fifth of caudal peduncle light; faint traces of a dark spot at base of each scale on dorsal region of body; all the fins except ventrals dusky.

One male specimen was taken. It resembles the females in general appearance. The anal fin is not advanced nor modified into an intromittent organ. Although it is injured, it shows that the first 5 or 6 rays were close together and shortened.

Xenendum xaliscone differs from *X. caliente* in not having villiform teeth; in having more scales in the lateral and transverse series and on caudal peduncle. It differs from *X. luitpoldii* (Steindachner), which is the third known species of the genus, in having a much longer snout, a more pointed head, and in not having villiform teeth.

Measurements of five female specimens of Xenendum xaliscone.

Measurements.	Locality: L. de Chapala near Ocotlan, Jalisco, Mexico.				
Length of body in millimeters	142	124	122	110	117
Depth of body expressed in hundredths of length	32	33	32	34	33
Depth of caudal peduncle	16	18	17	18	17
Length of head	22½	23	23	23	23
Width of interorbital space	13	14	13	14	13
Length of snout	7	8	8	7	7
Width of mouth	8	9	9	8	8
Diameter of orbit	6	6	6	6	6
Distance from snout to dorsal fin	66	64	65	66	66
Height of longest dorsal rays	15	15	13	15	17
Distance from snout to anal fin	70	69	69	69	68
Height of longest anal rays	11	13	12	13	......
Distance from anal to caudal fin	25	26	27	26	27
Length of caudal fin	21	21	20	21	20
Length of pectoral fin	18	20	19	20	21
Distance from snout to ventral fin	49	49	51	50	49
Length of ventral fin	13	14	14	13½	14
Number of rays in dorsal	13	13	12	12	12
Number of rays in anal	14	14	15	14	......
Number of scales in lateral series	42	41	40	40	40
Number of scales in transverse series	17	16	16	16	17
Number of scales on caudal peduncle	12	12	12	12	11

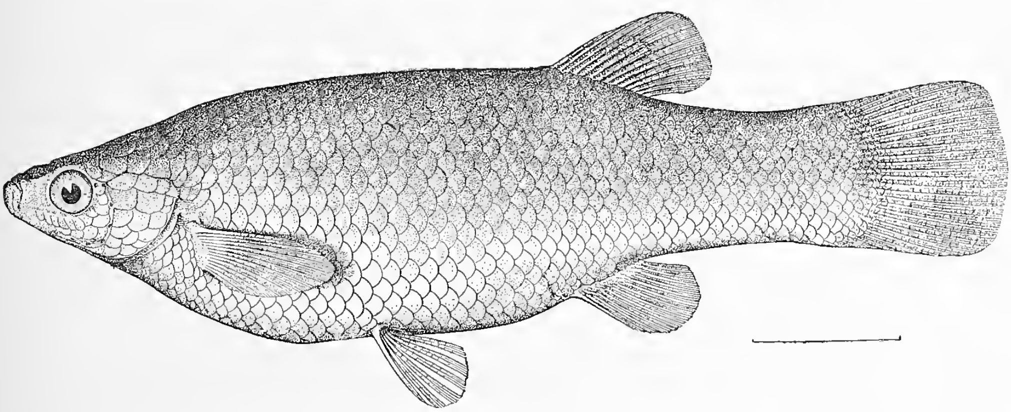


FIG. 9.—*Xenendum xaliscone* Jordan & Snyder, new species. Type.

25. Pœcilia limantouri Jordan & Snyder, new species. Fig. 10.

Type, a male, No. 6165, L. S. Jr. Univ. Mus. From Rio Tamesoe, near Tampico, Tamaulipas, Mexico. Collected by J. O. Snyder, January 12, 1899.

Head 3.5 in length; depth 3; depth of caudal peduncle 4.6; eye 3.5 in head; snout 3; interorbital space 2; height of dorsal 5.5 in length; anal 4.5; length of pectoral 4.5; ventral 6, caudal 3.5. D. 9. A. 9. Scales in lateral series 26; transverse series 9; on caudal peduncle 8.

Body rather deep and compressed; dorsal outline angular, its highest point at insertion of dorsal; lowest point of ventral outline at base of ventrals; head pointed; interorbital space wide and flat; eye large, nearer to tip of snout than to posterior edge of opercle a distance equal to diameter of pupil. Mouth very oblique, its width twice diameter of pupil; premaxillary protractile; distal end of maxillary visible; lower jaw projecting. Teeth in two series on both jaws; the outer series in a single row, small, pointed, loosely attached; second series barely discernible, in bands. Gill-openings extending above base of pectoral a distance equal to half diameter of orbit. Gillrakers on first arch 20, small and slender. Alimentary canal very long and slender.

Body and entire head except preorbital area, lips, and lower jaw covered with large scales; 3 rows of scales on base of caudal; small scales extending on interradial membranes of caudal, a distance

beyond basal scales about equal to diameter of eye. Dorsal inserted half way between base of caudal and anterior edge of pupil, its base contained $6\frac{3}{4}$ times in length of head and body, its height $5\frac{3}{5}$; the last rays a little higher than the first. Anal advanced close to base of ventrals; first and second rays short, closely attached to the next; third ray greatly enlarged and lengthened; a loosely attached, ovate, fleshy pad near its tip; fourth and fifth rays slender, as long as the third; tips of the third and fifth rays bent toward that of the fourth; sixth to ninth rays about half as long as third. Caudal rounded, its length contained $3\frac{1}{3}$ times in head and body. Pectorals rounded; their length contained $1\frac{1}{4}$ times in head. Ventrals pointed, extending to middle of longest anal ray.

Color in alcohol, light yellowish-olive; much lighter on breast and ventral part of head; posterior edges of scales dark; lower jaw, preorbital area, upper part of head, and a narrow, median dorsal stripe, dark; basal three-fifths of dorsal fin black; distal part of fin white; boundary between white and black parts more definite on anterior than on posterior part of fin; basal two-thirds of caudal dusky; distal part without color. Other male specimens have only a few small dark spots on dorsal and caudal.

Body of female more elongate than that of male; depth of caudal peduncle $5\frac{2}{3}$ in length. Dorsal fin inserted in advance of anal, its origin above anal opening; first rays highest. Ventrals extend to posterior edge of vent, but do not reach anal. The dorsal and caudal have a little dusky coloring.

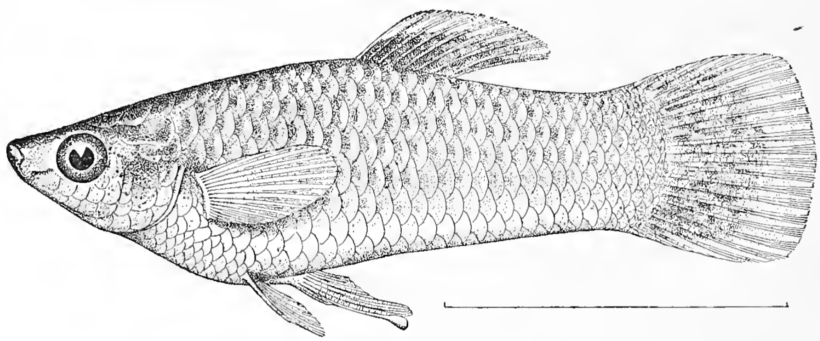


FIG. 10.—*Pœcilia limantouri* Jordan & Snyder, new species. Type.

Measurements of Pœcilia limantouri.

Measurements.	Locality: Rio Tamesoe, near Tampico, Tamaulipas, Mexico.										Locality: Rio Ixtla at Puente de Ixtla, Morelos, Mexico.			
	Male.					Female.					Male.		Female.	
Length of body in millimeters	46	44	42	42	38	57	53	48	44	44	40	37	49	42
Depth of body expressed in hundredths of length	32	32	35	32	32	27	29	30	33	30	32	31	30	31
Depth of caudal peduncle	22	22	21	20	20	17	18	18	19	19	23	20	18	20
Length of head	28	27	29	29	28	27	26	29	29	29	28	28	26	27
Width of interorbital space	13	14	13	14	14	14	14	14	15	15	13	12	14	13
Length of snout	10	10	10	11	$10\frac{1}{2}$	10	10	9	10	11	10	9	9	10
Width of mouth	10	9	$9\frac{1}{2}$	9	10	10	10	9	9	9	8	9	9	9
Diameter of orbit	8	8	9	8	9	8	8	8	8	8	8	8	7	8
Distance from snout to dorsal	56	56	55	56	57	62	58	60	61	60	57	58	61	66
Height of longest dorsal rays	18	17	17	17	16	11	13	13	17	14	26	24	18	16
Distance from snout to anal	50	52	53	53	55	66	63	64	65	65	52	48	66	67
Height of longest anal rays	22	22	24	24	23	15	16	16	14	15	24	23	17	19
Distance from anal to caudal	51	50	47	49	47	33	35	34	35	34	50	50	30	32
Length of caudal	30	29	30	28	28	26	26	24	25	27	33	30	28	28
Length of pectoral	23	23	22	23	23	20	20	22	21	22	25	22	22	21
Distance from snout to ventral	45	46	48	46	46	50	47	50	52	50	45	45	52	54
Length of ventral	17	18	17	13	18	13	13	13	12	13	19	18	13	13
Number of rays in dorsal	9	9	9	9	9	8	9	9	9	9	9	9	9	9
Number of rays in anal	8	8	8	8	8	8	8	8	8	8	8	8	8	8
Number of scales in lateral series	26	27	26	27	27	26	27	26	27	28	27	26	26	25
Number of scales in transverse series	9	9	9	9	9	8	9	9	9	9	9	9	9	9
Number of scales on caudal peduncle	8	8	8	7	8	8	7	8	7	8	8	8	8	7

Lack of material for comparison prevents our commenting on the probable affinities between *P. limantouri* and other species of the genus.

P. limantouri was numerous in the Rio Tamesoe and the lagoons near Tampico, and also in the Rio Verde near Rascon. We identify four specimens of *Pœcilia* collected at Puente de Ixtla, Morelos, with this species.

We take pleasure in dedicating this pretty fish to Señor Jose Yves de Limantour, the accomplished minister of the "Hacienda" for Mexico, in recognition of favors received through his courtesy.

26. Mollienisia latipinna Le Sueur.

A few specimens which we identify as *Mollienisia latipinna* were collected in the lagoons near Tampico. Some measurements of these are given.

Measurements of five specimens of Mollienisia latipinna.

Measurements.	Locality: Tampico, Mexico.				
	Male.		Female.		
Length of body in millimeters	43	35	41	37	28
Depth of body expressed in hundredths of length	38	36	36	34	34
Depth of caudal peduncle	23	21	20	20	18
Length of head	28	30	30	30	30
Width of interorbital space	15	16	15	15	15
Length of snout	10	10	11	10	12
Width of mouth	10	11	11	10	10
Diameter of orbit	9	10	10	10	10
Distance from snout to dorsal fin	53	47	52	49	48
Height of longest dorsal rays	21	20	15	14	16
Distance from snout to anal fin	56	56	66	63	64
Height of longest anal rays	22	24	18	16	17
Distance from anal to caudal fin	48	48	33	35	35
Length of caudal fin	30	28	25	27	28
Length of pectoral fin	25	25	21	23	23
Distance from snout to ventral fin	49	49	50	50	52
Length of ventral fin	19	20	15	15	15
Number of rays in dorsal	15	14	13	13	13
Number of rays in anal	8	8	8	8	8
Number of scales in lateral series	28	28	28	27	28
Number of scales in transverse series	9	8	9	9	9
Number of scales on caudal peduncle	7	7	7	7	7

As shown in the following table, there is considerable variation in certain characters between specimens of *M. latipinna* from different localities:

Measurements of Mollienisia latipinna.

Measurements.	Tampico, Mex.					Pensacola, Fla.					Savannah, Ga.					Withlacoochee, Fla.			
	Male.		Female.			Male.			Female.		Male.		Female.			Male.	Female.		
Width of interorbital space	15	16	15	15	15	13	13	13	14	14	14	14	14	14	14	15	16	15	16
Diameter of orbit	9	10	10	10	10	7	7	8	8	8	8	8	8	7	7½	10	10	9	9
Length of snout	10	10	11	10	12	9	9½	8	9	9	8	8	7½	8	9	9	9	10	10
Depth of caudal peduncle	23	21	20	20	18	25	23	23	20	22	24	22	19	18	19	20	20	19	18
Distance from snout to dorsal	53	47	52	49	48	32	33,	32	45	44	40	43	50	50	53	52	53	53	56
Distance from snout to ventrals	49	49	50	50	52	45	44	43	52	49	45	44	47	47	53	45	54	52	51

27. Xiphophorus montezumæ Jordan & Snyder, new species. Fig. 11.

Type, a female; No. 6145; L. S. Jr. Univ. Mus. From Rio Verde, near Rascon, San Luis Potosi, Mexico. Collected by J. O. Snyder January 24, 1899.

Head 4.20 in length, depth 3; depth of caudal peduncle 4.66; eye 3.25 in head; snout 3.25; interorbital space 2; height of dorsal 3.50 in length; anal 5; length of pectoral 4.20; ventral 4.50; upper rays of caudal 3.33; lower rays 1.10. D. 13. A. 7. Scales in lateral series 29; transverse series 9; on caudal peduncle 7.

Body deep, compressed; dorsal contour arched, its highest point at insertion of dorsal; caudal peduncle narrow and very deep; head small, pointed; interorbital space wide, slightly convex; eye large, a little nearer tip of snout than to posterior edge of opercle; mouth vertical. Teeth in two series; the first in a single row, minute, flat, and pointed, the second in a villiform band, much smaller and narrower than first, brownish colored, strongly curved backward. Gill-opening extending above base of pectoral a distance equal to diameter of pupil. Gillrakers on first arch 19, slender, the length of longest equal to half diameter of eye. Intestinal canal slender and long. Peritoneum black.

Scales on head and body large. One large, round scale on interorbital space, followed by 2; a row of 11 from the latter to first dorsal ray; 3 rows of scales on base of caudal fin.

Base of dorsal fin short, 4.16 in body; first ray shortest, the others graduated to the eighth, which is longest; the ninth, tenth, and eleventh shorter; twelfth and thirteenth longer; the abrupt shortening of ninth, tenth, and eleventh rays makes a notch in outline of dorsal. Anal advanced, its origin under third ray of dorsal; first ray greatly enlarged and lengthened, second and third equally lengthened, but more slender; these three with their connecting membranes form a half tube, with a pointed end; other rays half the length of first. Upper lobe of caudal rounded; 5 lower rays forming a very long, blunt appendage. Ventrals pointed, extending almost to tip of anal. Pectorals sharply rounded.

Color yellowish-olive, marked with black. During life there were 4 narrow longitudinal orange bands, each extending along a row of scales on body. Top of head and a median dorsal band

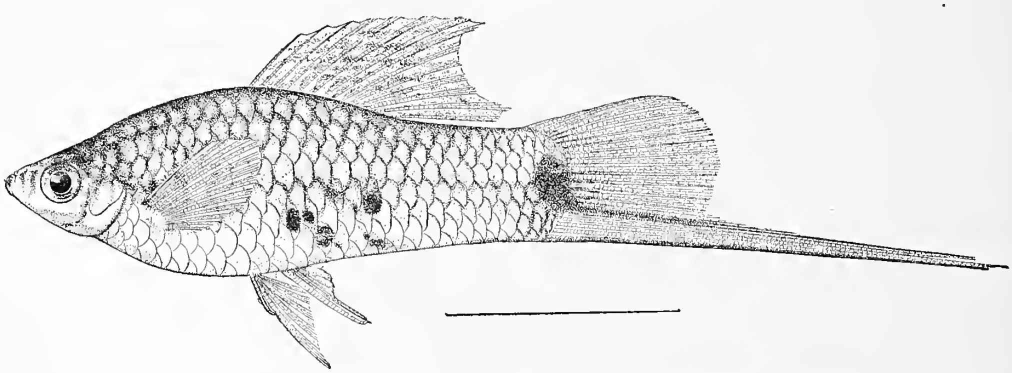


FIG. 11.—*Xiphophorus montezumæ* Jordan & Snyder, new species. Type.

extending to caudal, dusky; a narrow dusky band on edge of lower jaw; 2 short vertical bands on snout; 6 upper rows of scales edged with black, or dusky; a few black spots irregularly arranged on body above ventrals; a large black spot at base of caudal, its color extending along upper edge of prolongation; a dark line extending along lower edge of caudal peduncle to end of lower caudal rays; the caudal extension with a light central portion bordered with black; the lower border wider; under part of head and belly without dark color; dorsal fin with black dots and lines; pectorals, ventrals, and anals plain.

Considerable variation in shapes of fins and in color is shown among other male specimens. In some the fins are low or short, the caudal ornament represented only by a slight lengthening of lower rays. Among individuals, apparently fully grown, there is every gradation from the undeveloped to the very long caudal extension. In every case the scales are conspicuously dark-edged. In some examples black spots crowded together form a more or less definite dark line from eye to caudal, while below this line are large, irregular, black blotches. Others have no black spots, and the dark caudal patch has almost disappeared.

The females have the fins low or short, and without special modifications; the posterior edge of caudal, with the upper part rounded, the lower pointed. Scales dark-edged, a narrow, indefinite, dark, color-band usually present along median line of sides; the dark caudal patch is rarely absent. Fully grown males are scarce, a large catch consisting mostly of females and young.

Xiphophorus montezumæ is distinguished from other known species of the genus by having 7 anal rays, the scales with conspicuous dark edges, a large caudal spot, and the caudal appendage not sword-shaped, but with its end enlarged and blunt.

The following table of measurements will aid in distinguishing the species:

Measurements of eleven specimens of Xiphophorus montezumæ.

Measurements.	Locality: Rio Verde, near Rascon, Mexico.									
	Male.						Female.			
Length of body in millimeters	57½	52	57½	51	56	60	60	53	55	51
Depth of body expressed in hundredths of length	34½	34	36	33	36½	36	36	33	33	32
Depth of caudal peduncle	22½	22	21	20	20	20	19	18	17	18
Length of head	23	24	23	23	23	24	23	24	23	23
Width of interorbital space	11½	12	12	11	12	12	12	12	12	12
Length of snout	7	8	8	8	8	8	8	8	7½	8
Width of mouth	7	7½	7½	7½	8	7	7	7½	7	7½
Diameter of orbit	8	7½	7½	8	8	7	7	8	7½	8
Distance from snout to dorsal fin	46	47	47	46	47	49	49	49	50	48
Height of longest dorsal rays	31	28	24	25	22	20	16	14	15	16
Distance from snout to anal fin	55	58	58	55	57	59	61	61	64	63
Height of longest anal rays	19	22	22	20	21	17	16	16	17	17
Distance from anal to caudal fin	46	42	45	43	40	40	36½	34	32	35
Length of upper caudal rays	33	35	29	30	32	27	30	28	28	30
Length of lower caudal rays	90	88	60	43	43	36	30	29	30	30
Length of pectoral fin	25	26	23	25	25	24	24	22	23	22
Distance from snout to ventral fin	49	50	50	48	49	52	48	48	49	49
Length of ventral fin	23	.....	19	19	18½	16	15	15	16	16
Number of rays in dorsal	13	11	12	12	12	12	13	11	11	12
Number of rays in anal	7	7	7	7	7	7	7	7	7	7
Scales in lateral series	29	28	29	29	28	27	27	27	27	28
Number of scales in transverse series	9	9	9	8	9	9	9	9	9	9
Number of scales on caudal peduncle	7	7	7	7	7	7	7	7	7	7

ATHERINIDÆ.

28. Eslopsarum jordani (Woolman).

Two specimens of *Eslopsarum jordani* were collected, together with numerous individuals of *E. arge*, from the Rio Verde, Aguas Calientes, Mexico. *Chirostoma breve* Steindachner is probably identical with *E. jordani*, as supposed by Jordan & Evermann. An examination of a number of species of *Chirostoma* and two of *Eslopsarum* shows that the number of vertebræ, in addition to the character of the scales, furnishes a distinguishing generic feature.

	Vertebræ.
Eslopsarum jordani	38
arge	37
Chirostoma humboldtianum	44
chapalæ	45
promelas	45
diazi	44
crystallinum	44
lermæ	44
ocotlane	44

The species of *Chirostoma* may be divided into two very marked groups. The one represented by the typical species *Chirostoma humboldtianum* has the flesh firm, opaque, and deep olive-green in life. The other (*Lethostole*), typified by *Chirostoma estor*, has the flesh thin, translucent, and very pale. There are correlated differences in the firmness of the bones and scales, but thus far we have found no tangible character on which to separate *Lethostole* as a genus from *Chirostoma*. The known species of *Lethostole* are *estor, album, chapalæ, grandoeule, promelas, diazi, crystallinum, lermæ,* and *ocotlane.*

29. Eslopsarum arge Jordan & Snyder, new species. Fig. 12.

Type No. 6154, L. S. Jr. Univ. Mus. Collected by J. O. Snyder January 9, 1899, in Rio Verde, near Aguas Calientes, Mexico.

Head 4.25 in length; depth 4.33; depth of caudal peduncle 2.75 in head; eye 3.66; snout 3; interorbital space 3.33; height of spinous dorsal 3.33; soft dorsal 2; anal 2; length of pectorals 1.5; ventrals 2.5; caudal 1.2. D. IV, 8. A. 16. P. 13. Scales in lateral series 40; transverse series 11; between dorsals 5. Body rather thickset, deepest part just anterior to base of ventrals; width of body equal to distance from posterior edge of orbit to tip of snout. Eye nearer to tip of snout than to posterior edge of opercle a distance equal to diameter of pupil; interorbital space convex; width of preorbital area equal to diameter of pupil. Tip of lower jaw projecting beyond that of upper; mouth large, oblique; lips not much thickened posteriorly, the lower not distinctly folded over the upper at their angle; maxillary extending posteriorly to a perpendicular passing through anterior edge of orbit, its distal end below the level of eye. Teeth large, sharp, projecting backward, in 2 definite rows on each jaw, none on vomer or palatines. Gillrakers on first arch 14, long and slender.

Air bladder extending posteriorly to a point a little past insertion of anal. Peritoneum black. Vertebræ 37. Lateral line represented on the fifth row of scales below the dorsal by a series of partly developed pores; scales large, entire, covering head and body except snout, lower jaw, preorbital area, and a small space around bases of pectoral fins; small scales extending for a short distance on interradial membranes of caudal. First three dorsal spines of about the same height, the fourth shorter, first fully developed dorsal ray longest, the others gradually shorter, edge of fin straight; anal inserted on a perpendicular passing halfway between dorsals, its first fully developed ray longest, edge of fin slightly concave; caudal notched; pectorals rounded, extending to bases of ventrals; ventrals falling short of reaching vent a distance equal to diameter of orbit.

Translucent in life, a silvery lateral band with dark upper edge extending from upper part of base of pectoral to base of caudal, the band less distinct in region of pectoral fin; scales of back edged

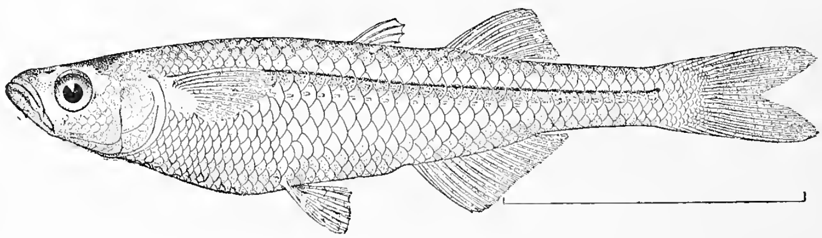


FIG. 12.—*Eslopsarum arge* Jordan & Snyder, new species. Type.

with fine, dark specks; snout, lower jaw, top of head, and upper part of eye dusky; dorsal and caudal fins with a little dusky coloring.

Specimens of *E. arge* were caught in the same seine-haul with *E. jordani*. The former differs from the latter in having a thicker body, a longer snout, a larger and less oblique mouth, a larger eye, and a wider color-band.

In the drawing accompanying the original description of *Eslopsarum jordani* the mouth is wrongly represented. Of the specimens examined, including some of the types, the mouth is much like that of *Chirostoma humboldtianum*. The cleft is not straight in outline. The lower lip folds over the upper at their union.

Measurements of ten specimens of Eslopsarum arge.

Measurements.	Locality: Rio Verde at Aguas Calientes, Mexico.									
Length of body in millimeters	56	63	58	53	54	53	53	51	51	52
Depth of body expressed in hundredths of length	22	20	19	19	20	19	19	20	20	20
Depth of caudal peduncle	9	8	8	9	9	9	8	9	9	8½
Length of head	24	23	23	23½	23	24	24	24	24	24
Distance from snout to occiput	18½	17½	17	18	18	17	18	18½	18	18
Tip of lower jaw to occiput	20	18½	18	19	19	18	19	19½	19	19
Width of interorbital space	8	7	7	8	7	7	8	7½	7½	7
Length of snout	7	7	7	7½	7	7	8	8	8	8
Diameter of orbit	6	6	6	6	6½	6½	6	6½	7	6
Distance from snout to spinous dorsal	52	52	52	50	53	52	53	54	52	52
Insertion of spinous dorsal to soft dorsal	15	14	13½	13	13	14	14	13	15	14
Height of longest dorsal spines	6	9	.....	8	7	7½	8	7	9½	8
Height of longest dorsal rays	12	14	12	14	13	13	12	15	14	13
Distance from snout to anal fin	60	58	59	57	61	58	57	58	57	57
Height of longest anal rays	13	13	14	11½	14	13	13	14	14	15
Distance from anal to caudal fin	23	23	23	24	25	23	24	23	23	24
Length of caudal fin	22	20	19	20	21	22	19	22	22	21
Length of pectoral fin	15	15½	15	15	15	16	16	16	15	16
Distance from snout to ventral fin	45	43	45	41	44	42	42	43	44	43
Length of ventral fin	10	10	9	10	10	10	10	11	10	10
Number of spines in first dorsal	4	3	4	4	3	4	3	4	4	4
Number of rays in second dorsal	8	8	8	9	9	8	8	8	9	9
Number of rays in anal	15	17	16	16	14	14	14	14	15	14
Number of rays in pectoral	13	14	13	14	13	13	12	13	13	13
Number of scales in lateral series	40	38	40	39	40	38	38	38	36	39
Number of scales in transverse series	11	12	11	11	10	10	10	11	10	10
Number of scales between dorsals	5	5	4	5	5	5	4	4	5	5

30. Chirostoma humboldtianum (Cuvier & Valenciennes). *Pescado Blanco de Chalco.*

Specimens of *Chirostoma humboldtianum* were very plentiful in the markets of the City of Mexico. They were said to come from the Lago de Chalco. This species is darker in color and much less translucent than any other *Chirostoma* collected by us The number of vertebræ is 44. It is the only species yet known referable to the typical subgenus *Chirostoma*.

Measurements of ten specimens of Chirostoma humboldtianum.

Measurements.	Collected in markets of City of Mexico.									
Length of body in millimeters	186	172	182	187	170	162	160	151	154	148
Depth of body expressed in hundredths of length	22	22½	20½	24	20	21	19	22	20	21
Depth of caudal peduncle	9	9	9	8	8½	9	8	9	9	9
Length of head	27	29	27½	26½	28	27½	27	26½	26½	27
Distance from snout to occiput	21	21	21	21½	20½	21	20½	20	20	21
Tips of lower jaw to occiput	22	22	22	23	21½	22	22	21	21	22
Width of interorbital space	7½	8	8	7	7	7½	7½	7	7	7
Length of snout	10½	10½	10	9	9	9	9	9	9	9
Diameter of orbit	5½	6	5½	5½	6	5½	5½	6	6	6
Distance from snout to spinous dorsal	52½	56	54	54	55	54	53	52	53	52
Insertion of spinous dorsal to soft dorsal	12½	14	13½	12	13½	12	11½	13	12	12½
Height of longest dorsal spines	7	6½	7½	6	6½	7½	8	7	8	8
Height of longest dorsal rays	14	11½	14	12	12	13	14	13	13	13½
Distance from snout to anal fin	63	64	63	62	60½	60	62	60	61	59
Height of longest anal rays	14	12½	14	12½	13	13	13	13	14	14
Distance from anal to caudal fin	22	21	21	22½	20	23	23	22	22	23
Length of caudal fin	20	19	19	20	17½	19½	20	19	19	20
Length of pectoral fin	20	17	18	18	17	19	19	18	18	20
Distance from snout to ventral fin	47	48	47	47	46	45	45	45	45	46
Length of ventral fin	12	11	11	11	10	12	12	11	11	12½
Number of spines in first dorsal	6	4	5	5	4	5	4	5	5	4
Number of rays in second dorsal	11	12	11	11	10	10	11	11	10	12
Number of rays in anal	19	18	18	18	19	18	18	19	19	18
Number of rays in pectoral	15	14	15	14	14	15	14	15	14	14
Number of scales in lateral line	54	50	52	52	50	54	54	55	55	54
Number of scales in transverse series	15	15	15	14	14	14	15	14	14	15
Number of scales between dorsals	7	6	7	6	7	8	7	8	7	8

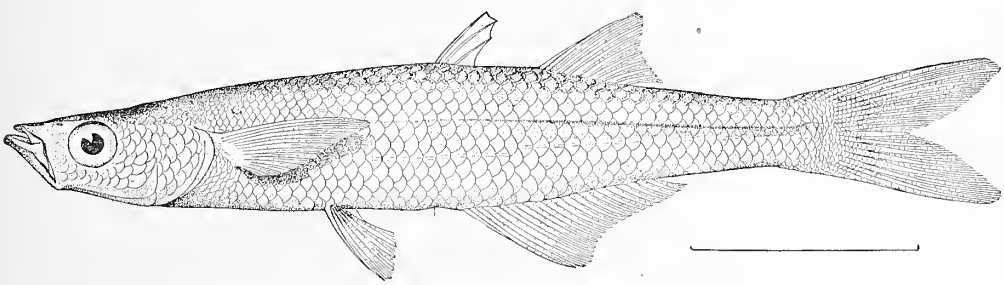


FIG. 13.—*Chirostoma chapalæ* Jordan & Snyder, new species. Type.

Subgenus LETHOSTOLE Jordan & Evermann.

31. Chirostoma chapalæ Jordan & Snyder, new species. *Pescado Blanco de Chapala.* Fig. 13.

Type No. 6155, L. S. Jr. Univ. Mus. Locality, Laguna de Chapala near Ocotlan, Jalisco, Mexico. Collected by J. O. Snyder, January 2, 1899.

Head 4 in length; depth 5.5; depth of caudal peduncle 3 in head; eye 3.66; snout 3.2; interorbital space 4; height of spinous dorsal 2.66; soft dorsal 1.75; anal 1.60; length of pectorals 1.25; ventrals 2.20; caudal 0.9. D. III–10. A. 21. P. 14. Scales in lateral series 49; transverse series 13; between dorsals 6.

Body slender, compressed, its deepest part below first dorsal. Eye large, nearer to tip of snout than to posterior edge of opercle, a distance equal to 1.5 times the diameter of pupil. Interorbital space convex, its width about equal to diameter of pupil or to preorbital area. Lower jaw projecting a little beyond tip of upper. Mouth oblique; lips thickened posteriorly, lower folding over upper at their union; premaxillaries anteriorly on a level with center of pupil; maxillary nearly vertical, its distal end in advance of a vertical from anterior edge of orbit a distance equal to two-thirds diameter of pupil. Teeth minute, in bands, not arranged in definite rows; no teeth on vomer or palatines. Gillrakers on first arch 30, very slender, the length of longest equal to diameter of orbit.

Peritoneum black. Air bladder very large, extending posteriorly to a point above middle of anal fin. Vertebræ 45. A well-defined lateral line extending along body on eighth row of scales below first dorsal. Scales large, crenate, not notably reduced in size nor closely crowded together on any part of body, except a small postoccipital patch; those anterior to pectorals small; scales extending on basal two-thirds of interradial membranes of caudal; lower jaw, snout, and preorbital space naked. First 2 spines of dorsal highest, the following 2 a little shorter; first ray of second dorsal

highest, others gradually shorter; anal inserted a little anterior to a perpendicular passing half way between origins of dorsals; first ray longest, others successively shorter; when the fin is elevated its edge is concave; caudal deeply forked, the tips pointed, pectoral notably pointed, extending past base of ventral a distance equal to diameter of orbit; ventrals extending to vent.

Translucent in life. A silvery lateral band 1 scale wide, bright and distinct posteriorly, becoming indistinct anteriorly; upper edge of lateral band dusky; scales on dorsal part of body edged with dark dots; jaws with dark dots; upper part of eye black; the dark, pigmented arachnoid shows through the thin skull.

C. chapalæ is closely related to *C. grandocule* Steindachner. It differs in having a smaller eye and larger scales. The former has 44 to 51 scales in the lateral series and 12 to 14 in a transverse series, while *C. grandocule* has 60 to 62 scales in the lateral series and 15 to 16 in a transverse series.

Measurements of seven specimens of Chirostoma chapalæ.

Measurements.	Locality: Laguna de Chapala.						
Length of body in millimeters	88	98	78	73	70	71	66
Depth of body expressed in hundredths of length	19	18	18	18	19	19	18
Depth of caudal peduncle	9	8½	9	9	9	9	9
Length of head	25	23	25	23	25	26	26
Distance from snout to occiput	18	17	19	17	19½	19	19½
Tips of lower jaw to occiput	19	18½	20	18	21	20	20
Width of interorbital space	6	6	6	6	6½	6½	6½
Length of snout	8	7	8	8	8	8	8
Diameter of orbit	6½	6½	7½	7	7	7½	7
Distance from snout to spinous dorsal	54	52	52	51	53	50	52
Insertion of spinous dorsal to soft dorsal	14	13	14	13	14	15	14
Height of longest dorsal spines	9	8	9	8	8½	10	10
Height of longest dorsal rays	14½	14½	15	14	16	16	16
Distance from snout to anal fin	60	59	60	57	57½	57	58
Height of longest anal rays	16	14	16	16	17	18	18
Distance from anal to caudal fin	22	20	22	23	20	21	20
Length of caudal fin	23	21	24	24	23	25	25
Length of pectoral fin	21	20	18	17	20	21	19
Distance from snout to ventral fin	43	41	43	30	41	41	42
Length of ventral fin	11	12	13	13	14	13	12
Number of spines in first dorsal	4	5	5	4	4	5	4
Number of rays in second dorsal	10	11	11	10	11	11	11
Number of rays in anal	20	20	21	18	20	21	19
Number of rays in pectoral fin	14	14	.....	14	14	14	14
Number of scales in lateral series	47	50	44	46	51	47	50
Number of scales in transverse series	13	13	12	13	14	14	14
Number of scales between dorsals	6	7	7	6	7	7	7

32. Chirostoma promelas Jordan & Snyder, new species.

Type No. 6161, L. S. Jr. Univ. Mus. Collected by J. O. Snyder, in market of Guadalajara, Jalisco, Mexico; said to have come from Laguna de Chapala, December 23, 1898.

Head 3.40 in length; depth 4.60; depth of caudal peduncle 3.33 in head; eye 5.66; snout 2.50; interorbital space 4.50; height of spinous dorsal, 3.60; soft dorsal 2.4; anal 2; length of pectoral 1.60; ventral 2.50; caudal 1.50. D. IV–11. A. 19. P. 15. Scales in lateral series 53, 16 in transverse series, 9 between dorsals.

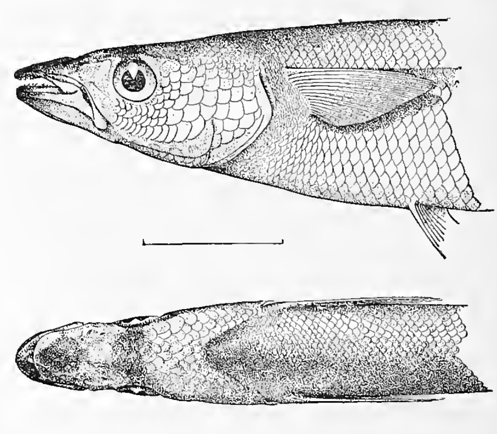


FIG. 14.—Lateral and dorsal views of head of *Chirostoma promelas.*

Head slender, triangular; eye smaller, nearer to tip of snout than to edge of opercle a distance equal to half the diameter of pupil; width of preorbital area somewhat greater than diameter of pupil; interorbital space slightly convex; snout pointed; upper jaw projecting a little beyond lower; cleft of mouth almost horizontal, lips enlarged posteriorly, the lower folding over the upper at their junction; angle of mouth on a level with lower part of pupil; maxillary almost vertical in position, its distal end not extending backward as far as anterior edge of orbit. Teeth large, curved inward, not arranged in definite rows, none on vomer or palatines. Vertebræ 45. A tolerably well-defined lateral line extending

along body about eight scales below the first dorsal, pores absent on some of the scales. Scales crenate, largest along lateral color-band; a postoccipital patch of minute, closely crowded scales extending backward nearly to a line connecting bases of pectorals; a narrow band of similar scales just posterior to gill-openings and on base of caudal; the latter extending on interradial membranes half their length; scales between dorsals not abruptly smaller than those near by, nor crowded closely together; head with scales except on snout, preorbital region, and on lower jaw.

First 3 spines of dorsal nearly equal in length, the fourth a little shorter; first dorsal ray longest, the others gradually shorter; anal inserted on a perpendicular passing midway between dorsals, first ray longest, others successively shorter, edge of fin slightly concave; pectoral pointed, extending beyond base of ventrals a distance equal to diameter of pupil; ventrals not quite reaching vent.

Color in alcohol yellowish-olive; a distinct silvery lateral band, the light color of which is underlaid with dark pigment, extending from upper part of base of pectoral to caudal, wider and brighter in color between dorsal and anal, growing narrower on caudal peduncle, widening at its end; scales of upper part of body with dusky coloring on edges; dorsals, pectoral, and caudal with dark color; eye dusky above, a dark band on interorbital space; snout and jaws black.

Chirostoma promelas is distinguishable from other known species of the genus by the projecting upper jaw and the black-colored snout. One specimen other than the type was obtained. In it the projection of the upper jaw is more pronounced than in the type. The gillrakers and abdominal viscera had been removed from both before they were purchased.

Measurements of two specimens of Chirostoma promelas.

Measurements.	Collected in Guadalajara market; said to have come from L. de Chapala.	
Length of body in millimeters	155	176
Depth of body expressed in hundredths of length	22	21
Depth of caudal peduncle	9	9
Length of head	30	29
Distance from snout to occiput	23½	22½
Tip of lower jaw to occiput	23	21½
Width of interorbital space	6½	6⅓
Length of snout	12½	12
Diameter of orbit	5	5
Distance from snout to spinous dorsal	59	56
Insertion of spinous dorsal to soft dorsal	12	10½
Height of longest dorsal spines	8½	6½
Height of longest dorsal rays	13½	11
Distance from snout to anal fin	65	63
Height of longest anal rays	15	13
Distance from anal to caudal fin	18	18
Length of caudal fin	20	18
Length of pectoral fin	18	17
Distance from snout to ventral fin	50	47½
Length of ventral fin	12	10
Number of spines in first dorsal fin	4	4
Number of rays in second dorsal fin	11	11
Number of rays in anal fin	19	20
Number of rays in pectoral fin	15	15
Number of scales in lateral line	53	56
Number of scales in transverse series	16	16
Number of scales between dorsals	9	8

33. **Chirostoma diazi*** Jordan & Snyder, new species. Fig. 15.

Type No. 6157, L. S. Jr. Univ. Mus. Obtained in market of Guadalajara, Jalisco, Mexico, by J. O. Snyder, December 23, 1898; said to have come from Laguna de Chapala.

Head 3.33 in length; depth 5; depth of caudal peduncle 3.25 in head; eye 5.33; snout 2.5; interorbital space 4.5; height of spinous dorsal 4.4; soft dorsal 2.5; anal 2.4; length of pectoral 1.6; ventral 3; caudal 1.4. D. v–11. A. 20. P. 15. Scales in lateral series 75; transverse series 22; between dorsals 22.

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*Since these pages were put in type we have received a paper entitled "Description of two Atherinoid fishes from Mexico," by Dr. G. A. Boulenger, in the Ann. Mag. Nat. Hist., series 7, vol. v, Jan., 1900, pp. 54–55. In this paper two species of *Chirostoma* are described from specimens collected in Lake Chapala by Mr. A. C. Buller. One of these (*C. lucius*) is perhaps our *C. lermæ*, and the other (*C. sphyræna*) is our *C. diazi*. These names of Boulenger have priority over ours, but it is, unfortunately, too late to suppress the latter.—D. S. J.

Body long, deeper, and more compressed than that of *C. humboldtianum;* head large, its dorsal contour straight from tip of snout to occiput; viewed from above the head is much compressed, the upper jaw sharply pointed and included by lower; interorbital space slightly convex; eye nearer tip of snout than to edge of opercle a distance equal to diameter of pupil; preorbital area a little wider than diameter of orbit; mouth oblique, its cleft extending to a horizontal from lower edge of orbit; lips thickened posteriorly, the lower forming a fold across the upper at angle of mouth; lower jaw projecting, the teeth just passing the edge of the upper; maxillary extending to a vertical from anterior edge of orbit, its distal end angular. Teeth large anteriorly, growing gradually smaller posteriorly, canine-like, sharp, projecting backward, not arranged in definite rows; none on vomer or palatines. Vertebræ 44. No lateral line.

Scales crenate, larger in region of lateral color-band, growing smaller dorsally and ventrally; abruptly smaller and closely crowded together in a region anterior to pectoral fin, extending from the isthmus to the occiput, also between the dorsal fins and along the bases of the dorsals, anal. and

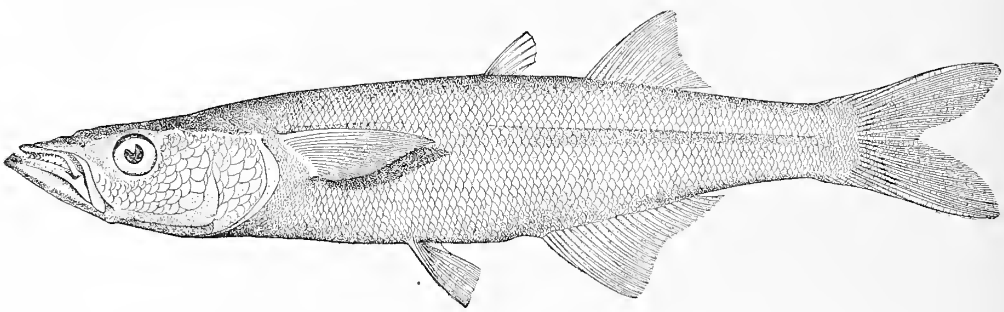

FIG. 15.—*Chirostoma diazi* Jordan & Snyder, new species. Type.

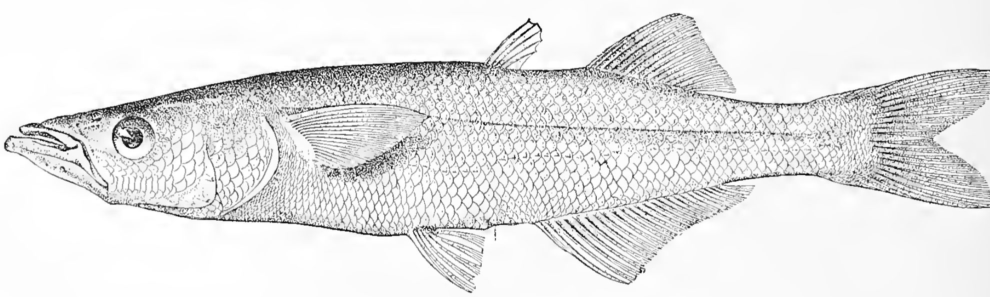

FIG. 16.—*Chirostoma crystallinum* Jordan & Snyder, new species. Type.

caudal; interradial membranes of the latter with scales extending two-thirds its length. Head with scales except on jaws, upper part of snout, and on preorbital area. Anterior spines of dorsal longest, others a little shorter; first dorsal ray longest, others gradually shorter; anal similar to soft dorsal in shape, except that its base is much longer; insertion of anal on a perpendicular passing halfway between dorsals; caudal deeply forked, the lobes obtusely pointed; pectorals sharp, extending past base of ventrals a distance equal to diameter of orbit; edge of pectorals, when extended, straight.

Body during life translucent; in alcohol greenish-olive; a silvery lateral band, in which the silver is not underlaid with black pigment, extending from axil to base of caudal; dorsal scales narrowly edged with dusky; upper part of eye dark. Our specimens are all from the market, the gill-arches and viscera having been removed. The flesh is somewhat shrunken, which probably causes the teeth to appear more prominent than in life.

Chirostoma diazi may be easily distinguished from the other known species of the genus by the small scales crowded closely together between the dorsal fins.

Named for Porfirio Diaz, the honored President of the Republic of Mexico, in recognition of his interest in the progress of science.

Measurements of six specimens of Chirostoma diazi.

Measurements.	Collected in Guadalajara market. Said to come from Laguna de Chapala.					
Length of body in millimeters	185	188	188	186	183	183
Depth of body expressed in hundredths of length	19	20½	22	20	20	21
Depth of caudal peduncle	8½	8½	9	9	9½	9
Length of head	30½	30	31	31	31	31
Distance from snout to occiput	22½	22	23½	22	23½	22
Tip of lower jaw to occiput	24	23½	25	24	25	24½
Width of interorbital space	6½	6	7	6½	6½	6½
Length of snout	12	12	13	12½	13	12½
Diameter of orbit	5½	6	5½	5½	5½	5½
Distance from snout to spinous dorsal fin	57½	55	55½	57½	56½	57½
Insertion of spinous dorsal to soft dorsal	14	14	14½	13	15	13½
Height of longest dorsal spines	7	6½	6½	7	7	7
Height of longest dorsal rays	12	12	14	13	12	12½
Distance from snout to anal fin	63	64	66	66½	66	66½
Height of longest anal rays	12	13	13	13½	13	13
Distance from anal to caudal fin	17	18	18	20	19	17
Length of caudal fin	18½	20	22	23	20	22
Length of pectoral fin	17	16	19	19	18½	18
Distance from snout to ventral fin	48½	47	50	50	50	50
Length of ventral fin	9½	10½	10	10½	10	10
Number of spines in first dorsal	4	4	5	5	5	4
Number of rays in second dorsal	12	11	12	11	11	12
Number of rays in anal	21	21	21	20	21	22
Number of rays in pectoral	15	15	15	15	15	15
Number of scales in lateral series	61	70	63	69	60	63
Number of scales in transverse series	21	20	20	20	20	20
Number of scales between dorsals	21	27	21	22	26	23

34. Chirostoma crystallinum Jordan & Snyder, new species. Fig. 16.

Type No. 6158, L. S. Jr. Univ. Mus. Locality, Laguna de Chapala, near Ocotlan, Jalisco, Mexico. Collected by J. O. Snyder, December 26, 1898.

Head 3.25 in length; depth 4.75; depth of caudal peduncle 3.50 in head; eye 5.75; snout 2.60; interorbital space 4.50; height of spinous dorsal 4.20; soft dorsal 2.50; anal 2.25; length of pectoral 1.80; ventral 2.75; caudal 1.75. D. v–13. A. 24. P. 16. Scales in lateral series 56; transverse series 18; between dorsals 10.

Body deepest above ventrals; widest at insertion of pectorals. Head long and pointed, its upper contour straight; snout viewed from above sharply pointed, the lower jaw projecting beyond upper a distance equal to a little more than half the diameter of pupil; eye nearer tip of snout than to posterior edge of opercle a distance equal to diameter of pupil; mouth oblique, the cleft extending downward to a level with lower edge of pupil; lips thickened posteriorly, the lower folding over the upper at angle of mouth. Teeth minute, in wide patches—not arranged in definite rows—on upper and lower jaws; no teeth on vomer or palatines. Gillrakers on first arch 27, slender, the length of longest equal to diameter of pupil. Vertebræ 44.

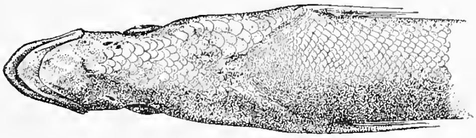

FIG. 17.—Dorsal view of head of *Chirostoma crystallinum*.

An indefinite lateral line extending along the body about 9 scales below first dorsal; the pores absent on many of the scales. Scales crenate, largest along color-band, growing smaller above and below, much smaller and closely crowded on body anterior to pectoral fin from isthmus to occiput; a few small scales at upper end of opercle, along bases of fins, and on interradial membranes of caudal for half its length; scales between dorsals large and not crowded together; lower jaw and upper part of snout naked. First 3 spines of dorsal about the same length, reaching, when depressed, to within one-third of their length of insertion of soft dorsal; first dorsal ray longest, others gradually shorter; anal inserted on a perpendicular passing through a point halfway between origins of dorsals, base much longer than that of dorsal; first dorsal ray highest, others gradually shorter to middle of fin; all of remaining rays of about the same height; caudal deeply forked, tips bluntly pointed, pectorals pointed, extending a little past bases of ventrals; tips of ventrals extending to vent.

Body during life translucent, with a slightly bluish tinge; in alcohol yellowish; dorsal scales with dusky edges; top of head dusky; upper part of eye dark; fins, except ventrals and anal, with a little dusky color; a silvery color band extending from upper part of pectoral base to caudal; narrower on caudal, widening at base of caudal.

C. crystallinum closely resembles *C. ocotlane* in general appearance. The much shorter lower

jaw and the smaller eye of *C. crystallinum* are at once distinguishing characters. Two specimens from the Guadalajara markets are shrunken, so that the orbit is larger and the teeth more evident than in those taken at Ocotlan.

Measurements of six specimens of Chirostoma crytallinum.

Measurements.	Laguna de Chapala.				Guadalajara market, Laguna de Chapala.	
Length of body, in millimeters	206	180	186	169	142	170
Depth of body expressed in hundredths of length	22	21½	21	20	20	21
Depth of caudal peduncle	8½	9	8	9	9	8½
Length of head	30½	31	31	29	31	31½
Distance from snout to occiput	22½	22	22½	22	23	23
Tip of lower jaw to occiput	24½	23½	25	23	25	24½
Width of interorbital space	6½	7	7	6½	6	5
Length of snout	12	12	12	11½	12	12
Diameter of orbit	5	5	5½	5½	6½	6
Distance from snout to spinous dorsal	57½	55½	56	55	56½	56½
Insertion of spinous dorsal to soft dorsal	11	13½	12	13	12	12
Height of longest dorsal spines	6½	8	7½	8½	8	8
Height of longest dorsal rays	13	12	13	13½	15	14½
Distance from snout to anal fin	66	65	63	61¼	65	66
Height of longest anal rays	13	14	13	14	16	16
Distance from anal to caudal fin	19	18	16	19	17	17½
Length of caudal fin	19	18	18	20	22	21
Length of pectoral fin	17	17	17	18½	20	20
Distance from snout to ventral fin	50	48	49	47	50	50
Length of ventral fin	11	11	11	11½	11½	12
Number of spines in first dorsal	4	5	5	5	5	5
Number of rays in second dorsal	11	12	13	11	11	11
Number of rays in anal	18	21	24	21	22	22
Number of rays in pectoral	14	14	15	14	14	14
Number of scales in lateral series	57	57	56	60	56	56
Number of scales in transverse series	18	19	18	17	19	......
Number of scales between dorsal fins	9	11	10	11	9	8

35. Chirostoma ocotlane Jordan & Snyder, new species.

Type No. 6160, L. S. Jr. Univ. Mus. Collected by J. O. Snyder, December 26, 1898, from Lago de Chapala, near Ocotlan, Jalisco, Mexico.

Head 3.33 in length, depth 4.50; depth of caudal peduncle 3.25 in head; eye 4.33; snout 2.60; interorbital space 5; height of spinous dorsal 3.5; soft dorsal 2.16; anal 2; length of pectoral 1.60; ventral 2.50; caudal 1.50. D. v-12. A. 20. Scales in lateral series 54; transverse series 19; between dorsals 11.

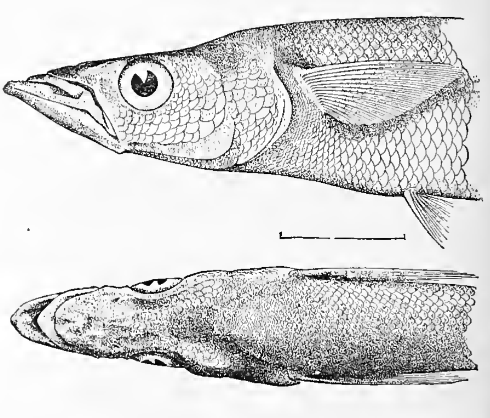

Fig. 18.—Lateral and dorsal views of head of *Chirostoma ocotlane.*

Body long, rather slender, deepest part above ventrals. Head long, pointed, its dorsal contour straight from tip of snout to a point a little posterior to the eye, where it curves upward; interorbital space flat; eye high up, nearer to tip of snout than to edge of opercle a distance about equal to diameter of pupil; width of preorbital space equal to diameter of pupil. Mouth oblique, cleft extending downward to a point opposite lower edge of pupil; lips growing more fleshy posteriorly, the lower forming a fold across the upper at their junction; distal end of maxillary angular; extending almost to a vertical from anterior edge of orbit; lower jaw very long, projecting beyond upper a distance equal to diameter of pupil; viewed from above, both jaws are a little more pointed than are those of *C. estor* or *C. humboldtianum.* Teeth on jaws in bands, minute, projecting backward; no teeth on vomer or palatines. Gillrakers slender, close together; length of longest equal to diameter of pupil. Vertebræ 44.

A rather indefinite lateral line extending along body 10 scales below the first dorsal; the pores absent on many of the scales. Scales crenate, growing smaller dorsally, larger ventrally; those on posterior part of occiput, on nape, on region anterior to pectorals—above and below—and on base of

caudal, very small and crowded together; those in the region of dorsals not reduced in size nor crowded except at insertion of fins, where there are 4 very small ones; cheeks with 5 rows; lower jaw and upper part of snout naked; basal half of interradial membranes of caudal with minute scales. First 3 spines of dorsal highest, extending when depressed within half their length of origin of soft dorsal; first dorsal ray preceded by a shorter, simple, closely attached one; other rays successively shorter than first; edge of fin slightly concave; anal similar to soft dorsal in shape, its basis 1.66 times as long as that of soft dorsal; attachment of first ray under a point halfway between insertions of dorsals; caudal deeply forked, the lobes equal; pectorals pointed when depressed; upper rays longest, extending to a vertical, halfway between insertions of first dorsal and ventrals.

Body, during life, almost translucent, with a bluish tinge of color. In alcohol the color is a light olive-yellow; a silvery lateral band extending from axil to base of caudal, the band wider and brighter in color between dorsal and anal, growing narrow on caudal peduncle and then widening again at its posterior end; head and body above, and the lower jaw dusky; upper part of eye dark; edges of scales above lateral band with small black dots; caudal somewhat dusky on its basal third; other fins with little or no dark color.

Chirostoma ocotlane is easily distinguished from all other known species of the genus by its excessively long lower jaw. Except the jaw and somewhat larger eye it resembles *C. estor** in general appearance. The following gives some exact measurements of the type and also shows some slight individual variations.

Measurements of ten specimens of Chirostoma ocotlane.

Measurements.	Laguna de Chapala.	Guadalajara market, said to have come from Laguna de Chapala.								
Length of body in millimeters	160	191	210	193	193	192	182	177	174	155
Depth of body expressed in hundredths of length	21½	22	22	21½	23	23	23	21½	21	18
Depth of caudal peduncle	9½	8⅓	8½	9	9	9	9½	9	9	8½
Length of head	31	31	32½	29½	32	32	32	32	32	32
Distance from snout to occiput	22½	22½	23	21½	22½	23	22½	23	23	22½
Tip of lower jaw to occiput	26	26	27	25	26	26½	26	26½	26½	26
Width of interorbital space	6	6½	7	6	6	6	6	7	6	5½
Length of snout	11½	11	12	11	12	12	12	12	12	11½
Diameter of orbit	7	6½	6½	6½	7	6½	6½	7	6	7
Distance from snout to spinous dorsal	56	56½	56	56	56½	57	56½	55½	55	55½
Insertion of spinous dorsal to soft dorsal	13½	12	13	13	12	12½	12	12½	13½	12½
Height of longest dorsal spines	9	9	8½	8½	8½	7½	8	9	8½	8
Height of longest dorsal rays	15	14½	13½	14	14½	13½	14	15½	15	15
Distance from snout to anal fin	63½	65	66	65½	65	63	64	64	65½	64
Height of longest anal rays	16	16½	15	15	16	15½	16	17	15	16
Distance from anal to caudal fin	20	17½	19½	18	19	18	19	18½	18½	19
Length of caudal fin	22	22	22	21	21½	21½	21½	23	22½	22
Length of pectoral fin	19½	21½	21½	19	20	20	19½	22	21	21
Distance from snout to ventral fin	48	50	51	48	50	48½	50	48	49	49
Length of ventral fin	12	12	13	12½	12	11	13	13½	12½	12
Number of spines in first dorsal	5	5	5	5	5	5	5	5	5	5
Number of rays in second dorsal	12	12	11	12	12	12	12	12	12	12
Number of rays in anal	20	20	19	21	19	22	21	20	21	21
Number of rays in pectoral	15	15	15	15	15	15	15	15	15	15
Number of scales in lateral line	54	56	55	54	56	57	53	53	57	57
Number of scales in transverse series	19	18	18	19	18	20	18	19	18	17
Number of scales between dorsals	11	11	11	10	12	13	12	10	11	12

* We have reexamined the type specimen of *Chirostoma estor*. The scales are small and closely crowded on the region anterior to the pectorals from the occiput to the isthmus; they are not much reduced in size nor closely crowded together between the dorsals. The teeth on the jaws are large and numerous; not arranged in definite rows; 3 vomerine teeth almost as large as those on jaws.

Some measurements of the type of *C. estor* expressed in hundredths of length of the body, are here given: Length of body in millimeters 212; depth of caudal peduncle 7.5; length of head 31.5; distance from snout to occiput 23; tip of lower jaw to occiput 24; width of interorbital space 7; length of snout 12; diameter of orbit 5.66; distance from snout to spinous dorsal 56.5; insertion of spinous to soft dorsal 12.5; height of longest dorsal spines 7; of longest dorsal rays 11; distance from snout to anal 62.5; height of longest anal rays 12; distance from anal to caudal 22; length of caudal fin 18.5; of pectoral fin 17; distance from snout to ventral 45.5; length of ventral fin 10.5; D. v–12; A. 18; P. 14; scales 72–19, 9 between the dorsals.

The type of *Chirostoma estor* agrees externally almost perfectly with Steindachner's account of *Chirostoma album* from Lake Patzcuaro, a species which he later places in the synonymy of *C. estor*. But the type localities are widely separated, and Steindachner found no trace of the large vomerine teeth so conspicuous in *C. estor*. We therefore regard *C. album* as probably a valid species not identical with *C. estor*.

36. Chirostoma lermæ Jordan & Snyder, new species.

Type No. 6159, L. S. Jr. Univ. Mus. Collected in market of Guadalajara; said to have come from Laguna de Chapala, Jalisco, Mexico. Collected by J. O. Snyder, December 23, 1898.

Head 3.16 in length; depth 5.33; depth of caudal peduncle 3.66 in head; eye 5.5; snout 2.66; interorbital space 5.5; height of spinous dorsal 4.5; soft dorsal 2.5; anal 2.16; length of pectorals 1.66; ventrals 3; caudal 1.6. D–IV, 11. A. 20. Scales in lateral series 58; transverse series 20; between dorsals 11. Body slender; deepest part in region of ventrals; caudal peduncle narrow; snout long and pointed; lower jaw slightly projecting, but not enough to include the upper. Eye large, nearer tip of snout than to posterior edge of opercle a distance equal to diameter of orbit or to width of preorbital space. Cleft of mouth extending to a horizontal through lower edge of orbit; lower lip folded over the upper at their union; maxillary extending posteriorly almost to a perpendicular from anterior edge of orbit, its distal end angular. Teeth large and strong, curved backward and inward, arranged in two definite rows, those of the inner row of the upper jaw and of the outer row of the lower jaw larger; none on vomer or palatines. Vertebræ 44.

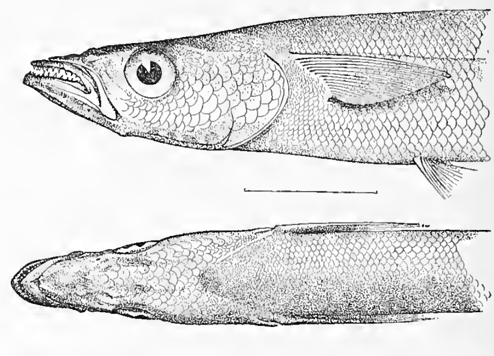

FIG. 19.—Lateral and dorsal views of head of *Chirostoma lermæ*.

An indefinite lateral line extending along body about 10 scales below first dorsal; the pores absent on many of the scales. Scales crenate; largest along the lateral color-band; much smaller between occiput and first dorsal; those immediately posterior to occiput minute and very closely crowded; a narrow edging of similar scales along gill-openings, extending ventrally to the isthmus; scales between dorsals not much reduced in size nor crowded together; basal half of interradial membranes of caudal with scales. First 2 spines of dorsal longest; third, shorter; fourth, about two-thirds as long as first; first dorsal ray longest, others gradually shorter; edge of fin straight; insertion of anal on a perpendicular passing through a point halfway between origins of dorsals; first ray longest, others successively shorter, last ray one-third the length of first; caudal deeply forked, its tips rather pointed; pectoral pointed, extending beyond origin of ventrals a distance equal to diameter of pupil; ventrals reaching vent.

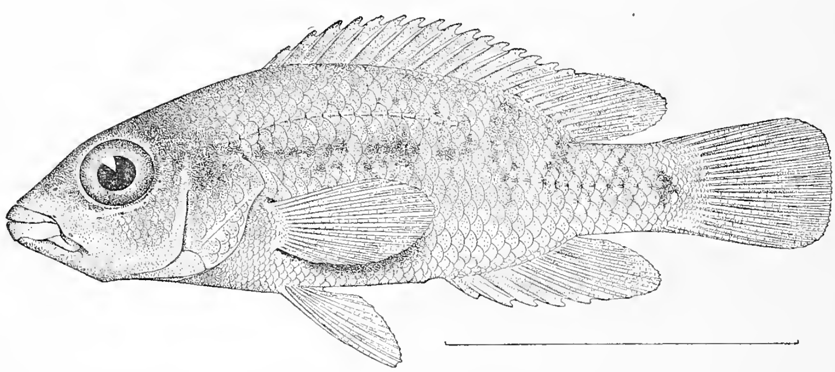

FIG. 20.—*Cichlasoma steindachneri* Jordan & Snyder, new species. Type.

Color in alcohol, light olive; a silvery lateral band, a scale in width, extending from upper part of base of pectoral to base of caudal; edges of upper scales dusky; a little dark color on dorsals, caudal, and pectoral; upper and lower jaws and top of head with minute dark dots; upper part of eye dark.

C. lermæ closely resembles *C. crystallinum*. It differs markedly in having large teeth which are arranged in two rows, a shorter lower jaw, and a larger eye.

Our specimens of *C. lermæ* are all from the market of Guadalajara. The gill-arches and viscera had been removed, and the bodies are somewhat shrunken.

Measurements of four specimens of Chirostoma lermæ.

Measnrements.	Collected in market of Guadalajara, said to have come from Lago de Chapala.			
Length of body in millimeters	162	152	145	150
Depth of body expressed in huudredths of length	21	19½	19½	18
Depth of caudal peduncle	9	8½	8½	8
Length of head	31½	32	32	33
Distance from snout to occiput	24	24½	25	24
Tip of lower jaw to occiput	26	25½	26	25½
Width of interorbital space	6	6½	6	6
Length of snout	12½	12	13	13
Diameter of orbit	6½	6	6	6⅓
Distance from snout to spinous dorsal	56	57	59	57½
Insertion of spinous dorsal to soft dorsal	12	13	13	14
Height of longest dorsal spines	7½	6½	8	8
Height of longest dorsal rays	13	14	14	12
Distance from snout to anal fin	63½	64	67½	64
Height of longest anal rays	14	15	15	14½
Distance from anal to caudal fin	17	17	17	17½
Length of caudal fin	19	20	21	21
Length of pectoral fin	19	19	19	19½
Distance from snont to ventral fin	47½	49	51	49½
Length of ventral fin	11½	11	12	11
Number of spines in first dorsal	4	4	5	4
Number of rays in second dorsal	12	11	10	11
Nnmber of rays in anal	22	20	19	20
Number of rays in pectoral	15	14	15	14
Number of scales in lateral series	54	58	55	58
Number of scales in transverse series	19	20	18	17
Number of scales between dorsal fins	12	11	11	11

CICHLIDÆ.

37. Cichlasoma steindachneri Jordan & Synder, new species. Fig. 20.

Type No. 6164, L. S. Jr. Univ. Mus. Collected by J. O. Snyder, January 24, 1899, from Rio Verde, near Rascon, San Luis Potosi, Mexico.

Head 2.5 in length; depth 3; depth of caudal peduncle 7.5; eye 3.40 in head; snout 2.80; interorbital space 5; longest dorsal spine 4; ray 2; longest anal spine 2.66; ray 2; length of pectorals 1.5; ventrals 1.75; caudal 1.5. D. XVI, 10. A. V, 9. P. 14. Scales in lateral series 30; in transverse series 16; on caudal peduncle 8.

Length of head exceeding its depth a distance equal to diameter of orbit. Body elongate, deepest above ventrals; curve of dorsal outline interrupted by a slight elevation above eye and a rather rapid descent at base of soft dorsal; ventral outline less curved than dorsal; interorbital space convex; orbit somewhat elongate laterally, located slightly nearer to tip of snout than to posterior edge of opercle; its lower edge a little above a horizontal from mouth to middle of caudal peduncle; cleft of mouth almost horizontal; maxillary, except distal end, concealed by preorbital; lips thick, the lower with a narrow frenum; jaws equal, the upper moderately protractile. Teeth in 2 series on each jaw; outer series in a single row, large, canine-like, far apart; inner series minute, in bands; tips of teeth brown colored; no teeth on vomer or palatines. Gill-membranes forming a fold across the isthmus. Gillrakers on first arch 10, short and blunt.

Body covered with large weakly ctenoid scales, head with cycloid scales; upper part of head anterior to middle of orbit, snout, preorbital area and ventral part of head naked; a single row of small scales along bases of dorsal and anal fins; small scales on basal part of interradial membranes of caudal. Lateral line interrupted at fourteenth scale, beginning again 3 scales lower and extending to base of caudal; first dorsal spine very short, others gradually longer to the sixth or seventh, after which the spines are of about the same length; sixth and seventh dorsal rays longest, about 1½ times length of longest spine; depressed fin extending to posterior edge of dark caudal spot; first anal spine shortest, one-fifth as long as fifth spine; fourth, fifth, and sixth rays longest; depressed fin extending to anterior edge of caudal spot; caudal fin evenly rounded; pectorals rounded, extending to a vertical from vent. Outer rays of pectorals longest, extending to vent.

Color in alcohol, light olive; darker above than below; an indistinct, dark lateral band extending from snout to caudal; 8 or 9 scarcely distinguishable dark vertical bands on sides of body; irregular dark spots at intersection of lateral and vertical bands; a small dark spot at base of caudal; small, distinct dark dots on anterior dorsal region of head.

Total length of type 61 millimeters. Younger examples, measuring about 43 millimeters, have the body a little deeper and the head shorter. The vertical color bands on posterior half of body are more distinct on the younger specimens.

Measurements of ten specimens of Cichlasoma steindachneri.

Measurements.	Locality: Rio Verde near Rascon, San Luis Potosi, Mexico.									
Length of body in millimeters	48	36	34	34	32	31	31	32	30	30
Depth of body expressed in hundredths of length	35	38	40	37	36	39	38	40	38	38
Depth of caudal peduncle	14	15	15	15	15	15	15	15	15	15
Length of head	40	37	38	39	35	37	38	40	37	36
Width of interorbital space	8	9	9	9	9	10	9	9	8	9
Length of snout	15	13	14	13	12	13	13	13	12	12
Diameter of orbit	12	12	13	12	12	12	12	13	12	12
Distance from snout to dorsal fin	47	45	47	45	43	45	45	46	45	46
Height of longest dorsal spine	12	13	14	16	14	13	14	14	15	14
Height of longest dorsal ray	20	20	20	21	19	19	20	18	18	19
Distance from snout to anal fin	72	68	67	68	69	70	69	69	66	68
Height of longest anal spine	16	13	15	15	14	15	14	16	15	15
Height of longest anal ray	19	20	20	20	17	19	28	22	20	19
Distance from anal to caudal fin	14	15	15	15	16	17	16	18	15	17
Length of caudal fin	28	28	30	28	26	25	27	30	25	25
Length of pectoral fin	26	29	28	26	26	27	27	31	26	25
Distance from snout to ventral fin	46	45	43	46	44	43	44	44	43	41
Length of ventral fin	23	25	24	23	20	23	23	24	23	22
Number of dorsal spines	16	16	16	16	16	16	15	16	16	16
Number of dorsal rays	10	10	10	10	9	9	11	10	10	10
Number of anal spines	5	5	5	5	5	5	5	5	5	5
Number of anal rays	8	8	8	8	7	8	8	8	8	8
Number of scales in lateral line	26	28	25	27	27	27	26	27	26	29
Number of scales in transverse series	14	14	13	14	15	15	14	15	14	14

38. Heros cyanoguttatus (Baird & Girard).

Some fishes from lagoons near Tampico we identify as *Heros cyanoguttatus*. They agree closely with descriptions of that species, but have a decidedly longer and sharper snout than has the specimen figured by Girard. (Girard, U. S. and Mex. Bound. Sur., Ichthyology, 30, pl. 4, figs. 9–12.)

39. Heros istlanus Jordan & Snyder, new species. *Mojarra*. Fig. 21.

Type No. 6150, L. S. Jr. Univ. Mus. Collected by Jordan & Snyder January 3, 1899, from Rio Ixtla at Puente de Ixtla, Morelos, Mexico.

Head 2.80 in length; depth 2.66; depth of caudal peduncle 7; eye 4.50 in head; snout 2.25; interorbital space 3.50; longest dorsal spine 2.80; ray (without filament) 1.40; longest anal spine 2.60; ray (without filament) 1.33; length of pectorals 1.50; ventrals 1.33; caudal 1.20; D. XVI, 10. A. V, 8. P. 14. Scales in lateral line 28; in transverse series 18.

Body elongate, compressed, deepest part above insertion of ventrals; dorsal outline rising rapidly to origin of dorsal, interrupted by a shallow notch above eye falling gradually to base of last spine, from which point the descent to the caudal peduncle is more abrupt; ventral outline evenly rounded. Interorbital space convex; eye large; orbit circular, equally distant from tip of snout and posterior edge of opercle; mouth horizontal, lower jaw projecting, lips thick, the lower without frenum, folding over the upper at their union; premaxillary protractile; maxillary small, nearly vertical in position, and almost hidden by the large preorbital. Teeth on both jaws in two series, the outer a single row of 24 canines; largest in front, growing smaller posteriorly; the inner series villiform; all of teeth with brown-colored tips. Gill-membranes free from isthmus. Branchiostegals 5. Gillrakers on first arch 9, short, blunt, far apart.

Body covered with large scales, the cheeks, opercles, subopercles, and occipital portion of the head with small scales; the ventral part of head, preorbital area, snout, and anterior part of interorbital space naked; one row of scales extending on bases of dorsal and anal fins; scales of body weakly ctenoid; scales of head smooth; lateral line interrupted on the nineteenth transverse row of scales, beginning again 3 scales lower down, and 2 scales in advance of where it left off and extending to base of caudal. First dorsal spine short and slender, others gradually longer and heavier; posterior spine longest; each spine with a distal extension of stiff membrane; tip of fourth ray of dorsal extending as a thread-like filament about as long as the diameter of orbit; dorsal, when depressed, extending on caudal one-third its length; first anal spine shortest; others growing gradually longer and heavier; the last $2\frac{1}{2}$ times as long as first; spines with distal attachments similar to those of dorsal; third and

fourth rays longest, united at their tips, forming a slender filament. The tip of anal extends a little farther posteriorly than that of dorsal. Caudal rounded. Tip of pectoral rounded. Ventrals located slightly posterior to bases of pectorals, extending to vent; outer ray longest, ending in a filament.

Color dark; an oblong brownish-black spot at base of each scale on sides of body, the spots growing less distinct above the pectorals; membranes of dorsal, anal, and caudal with small spots, these more distinct and regularly arranged on soft parts of dorsal and anal; pectorals and ventrals

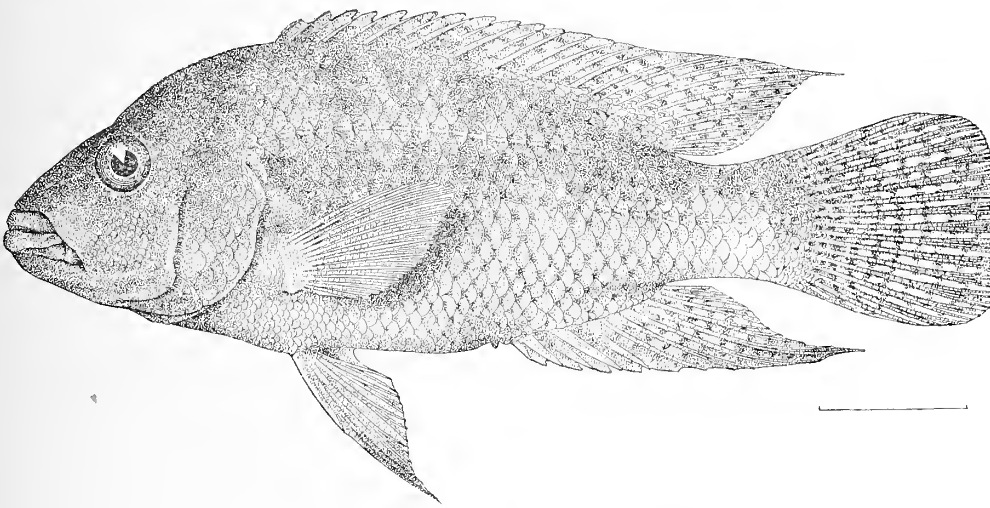

FIG. 21.—*Heros istlanus* Jordan & Snyder, new species. Type.

without spots. Young individuals have a brownish-black spot at base of caudal and on side of body at tip of pectoral, a less distinct spot at upper edge of gill-opening and also below posterior end of base of dorsal. The darker of these spots is sometimes faintly indicated on the larger individuals.

The annexed table shows the variations of some of the characters of the type and cotypes.

Measurements of ten specimens of Heros istlanus.

Measurements.	Locality: Rio Ixtla at Puente de Ixtla, Morelos, Mexico.									
Length of body in millimeters	131	129	122	117	112	107	77	55	43	29
Depth of body expressed in hundredths of length	39	37	38	38	35	41	40	35	38	40
Depth of caudal peduncle	15	14	14½	15	14	15	16	15	14	15
Length of head	35	35	35	35	36	37	37	37	36	39
Width of interorbital space	11	10	10	10	10	11	10	9	9	10
Length of snout	15	15	14	15	16	15	15	14	14	13
Diameter of orbit	7½	7½	8	7	7½	8	9	9	10	12
Distance from snout to dorsal fin	43	41	40	42	42	43	42	42	43	44
Height of longest dorsal spine	13	13½	15	14	15	16	16	13	16	15
Height of longest dorsal ray	25	30	24	25	26	27	26	24	24	18
Distance from snout to anal fin	68	68	67	70	71	70	70	68	69	65
Height of longest anal spine	14	13	16	14	13	15	16	16	14	15
Height of longest anal ray	30	26	28	26	25	28	25	23	23	20
Distance from anal to caudal fin	16	16½	16	16	15	16	16	18	15	16
Length of caudal fin	31	28½	31	30	28	31	31	29	28	25
Length of pectoral fin	23	25	26	25	23	25	26	25	26	25
Distance from snout to ventral fin	42	40	40	42	44	42	44	43	43	44
Length of ventral fin	27	24	27	24	23	25	24	24	23	21
Number of dorsal spines	16	16	16	16	16	16	16	15	16	16
Number of dorsal rays	10	11	11	10	10	10	10	10	10	10
Number of anal spines	5	5	6	5	5	5	5	5	6	5
Number of anal rays	7	8	8	7	8	7	7	7	7	7
Number of scales in lateral line	28	28	28	27	27	28	27	30	28	27
Number of scales in transverse series	18	18	17	17	17	17	16	17	16	16

40. **Neetroplus carpintis** Jordan & Snyder, new species. Fig. 22.

Type, No. 6162, L. S. Jr. Univ. Mus. Locality, Laguna del Carpinte, near Tampico, Tamaulipas, Mexico. Collected by J. O. Snyder, January 15, 1899.

Head 2.83 in length; depth 2; depth of caudal peduncle 6; eye 5 in head; snout 2.20; interorbital space 2.66; longest dorsal spine 2.20; ray 1.25; longest anal spine 2; ray 1.33; length of pectorals, 1.40; ventrals 1.20; caudal 1.16. D. XVI, 10. A. V, 8. P. 15. Scales in lateral line 27; in transverse series 17; on caudal peduncle 7.

Body compressed, deepest part above ventrals; dorsal outline straight from tip of snout to a point above anterior edge of orbit, where it is abruptly curved upward and backward to the origin of dorsal fin; from the latter point it gradually curves downward to base of first dorsal ray, from which point the descent to the caudal peduncle is abrupt; ventral outline evenly curved from snout to caudal peduncle. Interorbital space convex, its middle portion flattened. Orbit circular, nearer to posterior edge of opercle than to tip of snout a distance equal to diameter of pupil.

Mouth oblique, lower jaw slightly projecting; lips thick; the lower with a frenum equal in width to half the diameter of pupil; upper jaw protractile; maxillary covered by preorbital except at its distal end. Teeth in 2 series in each jaw, the outer series in a single row, flat or incisor-like, larger in front, growing much smaller posteriorly; the inner series minute, in narrow bands; all the teeth loosely attached, their tips brown-colored; no teeth on vomer or palatines. Gill-membranes forming a fold across the isthmus. Gillrakers on first arch 10; short, far apart.

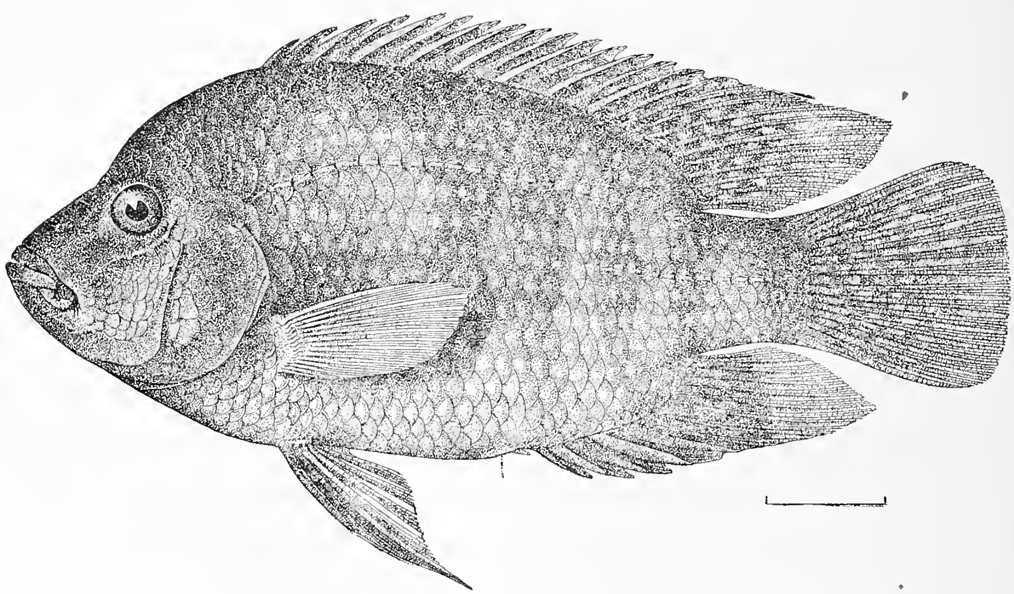

FIG. 22.—*Neetroplus carpintis* Jordan & Snyder, new species. Type.

Body covered with large, weakly ctenoid scales; cheeks, opercles, and occipital portion of head with small cycloid scales; lower jaw, snout, and anterior half of interorbital space naked; bases of posterior parts of dorsal and anal fins with small scales; interradial membranes of caudal with very small scales on basal parts; lateral line interrupted on nineteenth row of scales, beginning again 3 scales lower down, on the third row anterior to where it left off, and extending to base of caudal; 2 short rows of mucous tubes on interradial caudal scales, one above and the other below the end of lateral line. First dorsal spine shortest, others gradually longer and heavier, each spine with a ray-like attachment projecting above and posterior to its tip; first anal spine shortest, the others gradually longer and heavier, the fourth 3 times as long as the first; spines with distal attachments similar to those of the dorsal, third and fourth rays longest, extending posteriorly as far as those of dorsal; posterior edge of caudal somewhat convex; pectorals rounded; ventrals pointed, the outer ray much the longest, extending a little beyond the vent.

Color in alcohol, light slate; scales with lighter central spots; posterior parts of dorsal, anal, and caudal lighter; head in life covered with round and elongate spots of greenish-blue on a golden-brown background; sides of body with bluish and brownish spots irregularly arranged; pectorals and distal part of soft dorsal with yellowish tinge. In the young there are 5 or 6 dark vertical bands, about equal in width to diameter of orbit, on posterior part of body; a dark spot is sometimes present just below lateral line on a vertical through base of eleventh dorsal spine.

Neetroplus carpintis differs from *N. nematopus* and *N. nicaraguensis* in having a much deeper body and fewer dorsal and anal spines:

Species.	Dorsal.	Anal.	Lateral line.
Neetroplus carpintis	XV-XVII, 8-11	V, 8	24-29
nematopus	XIX, 10	VIII, 7	34
nicaraguensis	XVIII, 11	VII, 7	....

Besides the specimens taken in the Rio Tamesoe, a number of very small individuals of *N. carpintis* were collected in the Rio Verde near Rascon. They have rather indistinct, dark vertical bands on the entire length of the body, and in most cases a series of dark spots along the sides of the body; one at the base of the caudal and another under the eleventh dorsal spine being always present and the most distinct.

Measurements of ten specimens of Neetroplus carpintis.

Measurements.	Locality: Laguna del Carpinte, near Tampico, Tamaulipas, Mexico.									
Length of body in millimeters	162	161	132	129	119	66	55	57	54	49
Depth of body expressed in hundredths of length	51	55	55	54	55	49	49	50	49	51
Depth of caudal peduncle	17	17	17	16½	17	15	16	16½	16	17
Length of head	34	36	37	35	35½	38	38	40	38	39
Width of interorbital space	12	13	13	13	12½	10½	10	11	11	10
Length of snout	16	17	17½	17	16	15	15	16	15	15
Diameter of orbit	7	7	8	7½	8	9	10	10	10	11
Distance from snout to dorsal fin	42	43	46	43	45	44	45	46	46	45
Height of longest dorsal spine	17	16	18	18	18	16	15	17	17	16
Height of longest dorsal ray	31	31	30	28	30	23	25	26	25	27
Distance from snout to anal fin	73	75	72	75	71	70	72	72	70	70
Height of longest anal spine	16½	16½	19	18	18	18	19	19	16	18
Height of longest anal ray	27	29	28	28½	31	26	27	·24	25	26
Distance from anal to caudal fin	15	14	14	14½	15	15	15	14	15	15
Length of caudal fin	30	33	31	30	33	30	33	29	32	33
Length of pectoral fin	26	27	28	26½	28	28	28	30	29	29
Distance from snout to ventral fin	44	45	45	45	43	44	46	46	45	45
Length of ventral fin	30½	30	32	30	32	29	30	30	31	29
Number of dorsal spines	16	16	16	16	16	16	16	17	15	16
Number of dorsal rays	10	8	11	10	10	10	10	8	11	10
Number of anal spines	5	5	5	5	5	5	5	6	5	5
Number of anal rays	8	8	8	8	8	8	8	7	8	8
Number of scales in lateral line	26	27	26	26	29	27	24	27	25	26
Number of scales in transverse series	17	18	16	17	16	16	17	16	16	16

GOBIIDÆ.

41. Philypnus dormitor (Lacépède). Lagoons near Tampico.

42. Awaous taiasica (Lichtenstein). Rio Ixtla, Puente de Ixtla.

NOTES ON THE FLORIDA SPONGE FISHERY IN 1899.

By HUGH M. SMITH.

The sponge fishery of Florida between January 1 and December 31, 1899, presented a number of important features. In view of the great interest which has recently been manifested in this branch of our fisheries, and in order to bring up to date the published records of the industry, the following notes are published. The statistics for 1899, together with other information for that year, have been furnished by Mr. John K. Cheney, of Tarpon Springs, Florida, a leading buyer and packer of Florida sponges.

Key West and Tarpon Springs are now the only ports at which the cargoes of sponges are discharged and sold. At the former place in 1899 there were eight purchasing firms and at the latter six, two firms being represented at both places.

Key West is the headquarters of a large fleet of vessels and boats employed in sponging about the Keys and on the grounds off the west side of Florida, and is the exclusive market for the sponges taken on the southern and eastern coasts, although receiving a good proportion of the crop from the grounds to the northward.

Tarpon Springs is very conveniently located in the proximity of the important grounds off Rock Island and Anclote Keys, from which the largest quantity and best quality of sheepswool sponges come; and the prominence of the place as a sponge center has been increasing from year to year. In a report on the fisheries of Florida transmitted to Congress by the U. S. Commissioner of Fish and Fisheries in January, 1897, it was stated:

> The sponge industry of Tarpon Springs (or Anclote) is more extensive than that of any other place on the Florida coast except Key West. The recent increase in the business has been noteworthy, and it seems probable that the favorable position of the place with reference to the sponge-grounds will result in a still further development of the industry, which will make Tarpon Springs a formidable rival of Key West.

In 1895 the value of the sponges purchased at Tarpon Springs was only $60,000, or less than 15 per cent of the total value of the sponge crop of that year, while in 1899 the Tarpon Springs trade amounted to over $230,000, or more than 60 per cent of the aggregate value of the output.

The 1899 crop of sheepswool sponges on the Rock Island grounds was very large, exceeding the output of any season for quite a number of years. The sponges were, furthermore, of unusually large size. The explanation of the large catch is that clear water prevailed for a long time in localities where for several years the operations had been curtailed by turbid water and where, as a consequence, the sponges had been permitted to grow and multiply with little molestation. On the "spring trip" to these grounds many sponges weighing 2 to 3 pounds each were taken, and it is reported that

8,000 pounds were secured weighing from half a pound to 1 pound. At least half the catch on that trip consisted of sponges that weighed more than a quarter of a pound. These figures are significant in view of the fact that of late years the average weight of sheepswool sponges brought in has been only 1 or 1⅓ ounces. During the remaining part of the year the weights were the average for recent seasons. The total sheepswool crop was 153,700 pounds, of which 27,000 pounds were from the grounds about the Florida reefs.

Another feature disclosed by the data for 1899 is the greatly reduced catch of grass sponges, especially on the grounds off Anclote Keys, as compared with 1897. In the last-named year nearly 100,000 pounds of this cheap grade were landed from these grounds, but in 1899 less than 60,000 pounds were brought in.

The yield of yellow sponges was comparatively large and in excess of that of recent years, the grounds in the Gulf of Mexico and about the Keys producing about the same quantity, although in quality the Key sponges are better. The other sponges (boat, glove, etc.) were in about the usual quantity.

The financial outcome of the fishery in 1899 was very gratifying, being the largest in four years, although the aggregate quantity of sponges taken was less than in 1897. The prices at which the sponges sold were unusually high. It is said that as a rule the fishermen received better prices than ever before, and that there was an advance of fully 25 per cent over the previous year.

It is reported that throughout the year the sponge market was good, and that the demand was urgent and in excess of the supply. A considerable part of the catch of sheepswool sponges too large for toilet and other domestic purposes was disposed of to the ordnance departments of the United States and British armies and navies, for use in cleaning guns.

Following is a summary of the approximate quantity and value of the sponges of various kinds taken from the different grounds in 1899:

Kinds of sponge.	Pounds.	Value.	Average price per pound.
Rock Island sheepswool	126,700	$278,390	$2.20
Key sheepswool	27,000	54,000	2.00
Rock Island and Anclote yellow	28,000	7,205	.25
Key yellow	27,000	9,000	.30
Rock Island and Anclote grass	59,400	11,819	.20
Key grass	17,500	2,500	.15
Boat or velvet	8,000	4,000	.50
Glove	10,000	1,000	.10
Total	304,400	367,914	1.21

The following comparative statistics of the Florida sponge catch show, for four years, the quantities of the different kinds purchased from the sponge fishermen and the prices paid:

Kinds.	1895.		1896.		1897.		1899.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Sheepswool	231,272	$363,107	149,724	$248,196	157,476	$240,599	$153,700	$332,390
Yellow	29,509	11,798	23,655	9,318	32,362	13,082	55,800	16,205
Grass	21,387	5,464	44,617	11,508	128,622	29,188	76,900	14,319
Other	23,952	6,502	18,315	3,990	13,086	3,171	18,000	5,000
Total	306,120	386,871	236,311	273,012	331,546	286,040	304,400	367,914

Notwithstanding the large yield of sheepswool sponges in 1899, that species represented only 50 per cent of the catch, against 63 per cent in 1896 and 75 per cent in 1895. The yellow and grass sponges, which in 1895 constituted only 16½ per cent of the aggregate crop, in 1899 amounted to 44 per cent. While exceptional seasons like 1899 may give a temporary upward trend to the sheepswool production, there are no reasons for believing that the general downward tendency will not continue, and that the cheaper grades of sponges will not enter more largely into the catch.

The following table shows the relative importance of the different kinds of sponges, the figures being the percentages of the total quantity and value of the crop for a series of years:

Kinds.	1895.		1896.		1897.		1899.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Sheepswool	75.55	93.86	63.36	90.91	47.50	84.11	50.49	90.34
Yellow	9.64	3.05	10.01	3.41	9.77	4.57	18.33	4.41
Grass	6.99	1.41	18.88	4.22	38.79	10.21	25.26	3.89
Others	7.82	1.68	7.75	1.46	3.94	1.11	5.92	1.36
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Contributions from the Biological Laboratory of the U. S. Fish Commission,
Woods Hole, Massachusetts.

SOME CHEMICAL CHANGES IN THE DEVELOPING FISH EGG.

By P. A. LEVENE,
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The two chief functions of living matter are growing and dying, but of these only the latter has attracted sufficient attention of the biological chemist, and our knowledge of the process of growth remains very unsatisfactory. Most of what has been studied in that direction up to the present time has been done by the plant physiologist. The developing egg offers very good material for the study of this subject in relation to the animal kingdom, hence this work.

The substances most peculiar to the living organisms are the different nitrogenous compounds that take part in the formation of the proteid compounds and reappear on the decomposition of the latter. These compounds may be classified in a general way into two groups: First, those consisting of carbon, hydrogen, oxygen, and nitrogen; and, second, those in which some other elements, mainly sulphur, phosphorus, and fluorin (each of them separately or all together) join the former in the formation of their molecule.

The first group may be again divided into substances with a well-defined acid nature, as the monoamido acids, like leucin, and into those of a well-defined basic nature, which are very numerous and quite different in their composition.

The second group may be divided into simple proteids, containing only carbon, nitrogen, hydrogen, oxygen, and sulphur, and combined proteids as nucleo compounds, mucin, etc. It is the molecule of the latter compounds that may contain, besides carbon, hydrogen, oxygen, and nitrogen, also phosphorus and fluorin.

The aim of this work was to study the distribution of nitrogen between the main groups just enumerated, in different stages of the development of the egg, or, to be more precise, to attempt to estimate the quantity of nitrogen in the form of compounds not basic by nature, like amido acid, those in the form of bases, and finally those in the form of proteids. Further, an attempt was made to ascertain whether in the course of development a new formation of the combined proteids (only the nucleo-compounds were dealt with) was taking place. The amounts of ash and water were also estimated.

The material used was the egg of the cod. It was examined in the following four stages: Unfertilized, 24 hours after fertilization, 11 days after fertilization, and about 20 days after fertilization. All the material was furnished by the courtesy of the United States Fish Commission from its station at Woods Hole, Massachusetts.

The results of the analyses are presented in the following series of seven tables, showing the chemical changes in the developing cod egg during four different periods:

I.—*Water and ash determinations.*

Character of eggs.	Total substance (grams).	Dry substance.		Ash.	
		Grams.	Per cent.	Grams.	Per cent.
Unfertilized	9.7612	0.5737	5.33	0.058	10.09
24 hours after fertilization	8.2201	0.4760	5.20	0.0648	17.17
11 days after fertilization	7.06005	0.564	7 98	0.099	17.55
20 days after fertilization	8.097	0.5315	6.31	0.1045	19.66

II.—*Distribution of nitrogen.*

Character of eggs.	Total substance (grams).	Total nitrogen (grams).	Percentage of nitrogen.	Average.
Unfertilized	0.5405	0.059568	11.01	10.90
	0.403	0.0438	10.80	
24 hours after fertilization	0.3914	0.039858	10.16	9.96
	0.4299	0.042048	9.77	
11 days after fertilization	0.2985	0.033288	11.15	11.22
	0.3225	0.036354	11.29	
20 days after fertilization	0.318	0.029346	9.52	9.52

III.—*Nitrogen in phosphotungstic precipitate* (= *proteids* + *bases*).

Character of eggs.	Total substance (grams).	Nitrogen.		
		Grams.	Per cent.	Average.
Unfertilized	0.3670	0.03066	8.32	8.60
	.2956	.02628	8.88	
24 hours after fertilization	.1791	.014016	7.82	7.83
	.3296	.025842	7.84	
11 days after fertilization	.2855	.024528	8.52	8.68
	.3366	.029784	8.85	
20 days after fertilization	.2251	.021462	9.53	9.53

IV.—*Proteid nitrogen.*

Character of eggs.	Total substance (grams).	Nitrogen.		
		Grams.	Per cent.	Average.
Unfertilized	0.1650	0.012264	7.43	7.29
	.2940	.020828	7.15	
24 hours after fertilization	.5267	.028470	5.40	5.33
	.5504	.028808	5.26	
11 days after fertilization	.5535	.041610	7.52	7.27
	.654	.04599	7.03	
20 days after fertilization	.2575	.01752	6.84	6.84

V.—*Distribution of nitrogen in eggs of different ages.*

Character of eggs.	Nitrogen in monoamido compounds.		Nitrogen in form of bases.		Nitrogen in form of proteids.	
	Percentage to dry substance.	Percentage to total nitrogen.	Percentage to dry substance.	Percentage to total nitrogen.	Percentage to dry substance.	Percentage to total nitrogen.
Unfertilized	10.90—8.60=2.30	21.10	8.60—7.29=1.31	12.07	7.29	66.00
24 hours after fertilization	9.96—7.83=2.13	21.37	7.83—5.33=2.50	25.10	5.33	53.57
11 days after fertilization	11.22—8.67=2.55	22.72	8.67—7.27=1.40	12.48	7.27	64.79
20 days after fertilization	9.52—9.53=0.01	....	9.53—6.84=2.69	28.25	6.84	71.84

VI.—*Digestive experiments.*

Character of eggs.	Substance (grams).	Residue.	
		Grams.	Percentage.
24 hours after fertilization	2.0442	0.0428	2.08
11 days after fertilization	1.698	.0570	3.35
20 days after fertilization	1.7767	.1297*	7.24

* Phosphorus determination in the residue of eggs 20 days after fertilization, 0.137 grams of the residue: MgP_2O_3=0.014 gr., P=2.65 per cent.

VII.—*Determination of the nucleo-bases.*

Character of eggs.	Substance.	Grams.	Per cent.
Unfertilized	1.8611	0.0022	0.12
24 hours after fertilization	2.0227	.0438	2.16
11 days after fertilization	1.519	.0325	2.14
20 days after fertilization	1.2132	.0455	3.75

It would be premature to draw any very broad conclusions from the little work done for the present. Such conclusions should be deferred until the data have increased considerably. The results of this work, however, tend to indicate that in the developing fish egg the processes of synthesis are preceded by those of decomposition. (Consult Table V.) In the first stage after fertilization the proteids diminish in quantity; basic nitrogenous substances are formed at their expense. Later the basic substances decrease in quantity and proteids grow. Whether the molecules of those proteids are formed from the basic substances will be investigated in the future. It is also seen that the character of the proteids is changed during the development of the egg, the combined proteids as we may term them, such as nucleoproteids, increasing greatly in quantity. The importance of mineral salts for the formation of tissues can be illustrated by the increasing quantity of mineral substances in the egg in the course of its growth.

Contributions from the Biological Laboratory of the U. S. Fish Commission,
Woods Hole, Massachusetts.

THE FREE-SWIMMING COPEPODS OF THE WOODS HOLE REGION.

By WILLIAM MORTON WHEELER, Ph. D.,
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An attempt to gain some knowledge of the pelagic copepod fauna of New England requires little justification, for even the most superficial student of marine zoology can not fail to be impressed by the vast number and variety of these little crustaceans and their mysterious appearance and disappearance at the surface of the sea. The closer observer will be attracted by the beautiful modifications of their structure, the interesting homologies of their parts—always a fascinating study in any group of arthropods—their peculiar sexual dimorphism, and their remarkable geographical and bathymetrical distribution. Then there is the great economic value of these creatures, which, as veritable "insects of the sea," do inestimable service as scavengers and as the primitive and staple food supply of larger marine animals, such as fishes and cetaceans. Nevertheless, no group of animals has been more neglected by the zoologist, at least in America. This is probably attributable to a natural disinclination to take up the study of so large and intricate a subject—a disinclination which would have deterred the present writer from undertaking this study, had he not found in the recently published masterly monograph of Giesbrecht such an adequate treatment of the free-swimming copepods that the identification and study of our species has become a pleasant and easy task. That I have followed him closely, without extensive reference to preceding writers—although I have consulted the monographs of Dana, Claus, Brady, and Thompson—is warranted by the undisputed superiority and the comprehensive character of his work. Still, Giesbrecht's work is only a magnificent beginning.

During the few brief months that I have been able to devote to a study of our species I have gained the conviction that many new species, and even genera, occur in American waters. In the present paper I have described a few of the common species that are new, but a description of certain forms which seem to be types of new genera are reserved for closer study and subsequent publication.

The materials for the following study were collected in the tow at the U. S. Fish Commission wharf, Woods Hole, Mass., in July and August 1899; Vineyard Sound, near Gay Head, Marthas Vineyard, July; Gulf Stream, 60 to 80 miles due south of Marthas Vineyard, July; and Plymouth Harbor, Massachusetts, August. The last two localities, one representing an arctic, the other a tropical fauna, are within a day's journey of Woods Hole, and have been included in my study because they are easily accessible on the schooner *Grampus* and the steamer *Fish Hawk* and because many of the species of these regions will probably be found as stragglers at Woods Hole when

the fauna of the latter locality has been more extensively studied. To my friend, Prof. H. C. Bumpus, director of the Woods Hole station, I wish to express my sincere gratitude for many kindly and helpful suggestions during the progress of the work.

It was thought best to publish the work in its present form in order that it might be useful, even as a fragment, in a quantitative determination of the Woods Hole plankton soon to be undertaken. The dichotomic table, the synopses of the genera of which I have been able to find representatives, and the salient specific characters are translated from Giesbrecht. Simple camera drawings, in nearly all cases from the actual specimens, have been introduced for the purpose of facilitating identification.

The body of a free-swimming copepod is readily separable into two portions, a cephalothorax and an abdomen. The former consists of the head and 5 thoracic segments (first suborder, *Gymnoplea*). The head is often fused with the first thoracic, the fourth with the fifth. In the second suborder of the group, the *Podoplea*, the last thoracic segment is drawn into the portion known as the abdomen. The abdomen, consisting typically of 5 segments in the male and always of less than 5 in the female, may have the number reduced through fusion to 2, or even to a single segment. The first abdominal segment bears the reproductive openings and is known as the genital segment; the last contains the orifice of the alimentary canal and is called the anal segment. This segment bears the furca, a pair of appendages each of which is fringed with a series of bristles, typically 6 in number, varying in their relative length and character. The anterior portion of the cephalic segment is called the front. It terminates in the rostrum, which consists of 1 or 2 pointed projections.

The pairs of appendages which articulate with their respective segments in the cephalothorax are in their order: (1) the anterior pair of antennæ; (2) the posterior pair of antennæ; (3) the mandibles; (4) the maxillæ; (5) the anterior maxillipeds; (6) the posterior maxillipeds; (7) four pairs of swimming feet; (8) the fifth pair of feet, which are peculiarly modified in both sexes. Appendages 3 to 6 are known as the mouth parts. All except the first pair of antennæ are typically biramous; i. e., each appendage consists of an unpaired 2-jointed basal portion, bearing a 2 or 3 jointed inner and outer ramus (endopodite and exopodite) at its tip. One or both of the rami may be suppressed. The first pair of appendages, the anterior antennæ, consists typically of 25 joints, numbered from the base to the tip, but this number may be much reduced by fusion. The joints bear modified bristles and sense-hairs, or æsthetasks, as Giesbrecht appropriately calls them. In the Gymnoplea each joint commonly bears a cluster, consisting of a pair of bristles and an æsthetask. In the male one of the anterior antennæ (usually the right), or both, may be modified to form a geniculating grasping organ. Since nearly all of the appendages are more or less flattened, it is convenient to distingush certain regions, with reference to the body of the animal, as the anterior and posterior surfaces, inner and outer, and proximal and distal margins of the various joints. The number, arrangement, and character of the bristles on these different surfaces are of considerable taxonomic value. The mouth parts may be provided with bristle-fringed lobes.

For identification only adult copepods should be selected. This is not always an easy matter, as the tow frequently contains immature specimens. The adult male is most easily recognized, because in the majority of the genera it has striking secondary sexual characters either in the fifth pair of legs or in one or both of the anterior antennæ. The adult female is less easily distinguished unless found carrying eggs or with spermatophores attached to the genital segment. It is usually necessary to

dissect off the appendages, especially the feet, in order to determine the genus to which a particular form belongs. Permanent preparations of these or of the whole animals are easily made by simply adding a drop of Farrant's medium to the sea water or formalin under the cover-glass.

TABLE OF THE GENERA.

[Genera represented in the Woods Hole fauna are indicated by an asterisk.]

Inner ramus of first to third foot 3-jointed, of fourth foot 3-jointed to lacking. (*Arietellus, Augaptilus, Calanus*, Centropages*, Disseta, Hemicalanus, Heterochæta, Isias, Leuckartia, Metridea*, Phyllopus, Pleuromma, Ægisthus, Clytemnestra*, Microsetella, Monstrilla, Oithona*, Thaumaleus*) .... A

Inner ramus of first foot 3-jointed, of the second to fourth foot 2-jointed. (*Anomalocera*, Parapontella, Pontella*, Pontellina, Monops*, Corynura**) .... B

Inner ramus of first foot 2-jointed, of the second foot 2 or 3 jointed, of the third and fourth foot 3-jointed. (*Acrocalanus, Calocalanus*, Eucalanus*, Leuckartia, Paracalanus*, Rhincalanus, Temora*, Ægisthus, Euterpe, Miracia*, Setella**) C

Inner ramus of first to fourth foot 2-jointed. (*Acartia*, Calanopia, Candace*, Centropages*, Corynura*, Labidocera*, Temora**) .... D

Inner ramus of first foot 1-jointed, of second to fourth foot 3-jointed (anterior antennæ about twice as long as cephalothorax; fifth foot with 3-jointed outer ramus and no inner ramus) .. *Mecynocera**

Inner ramus of first foot 1-jointed, of second foot 2-jointed, of the third and fourth foot 3-jointed. (*Clausocalanus*, Ctenocalanus, Drepanopus, Gaëtanus, Mœbianus, Phaënna, Pseudocalanus, Scolecithrix, Spinocalanus, Xanthocalanus* .... E

Inner ramus of first and second foot 1-jointed, of the third and fourth foot 3-jointed. (*Aetidius, Chiridius, Euchæta, Euchiriella, Undeuchæta*) .... F

Inner ramus of first and second foot 1- or 2-jointed, of the third and fourth foot 1-jointed ... *Mormonilla*

A. Between anterior antennæ and first pair of feet no appendages .... (*Monstrillidæ*) A 1

Between anterior antennæ and first pair of feet usually all 5, or at least (*Copilia* ♂) 2 pairs of appendages (posterior antennæ, posterior maxillipeds) .... A 2

A 1. Anterior antennæ not geniculating; ventral surface of genital segment with furcate, setiform appendage .... A 1 ♀

Anterior antennæ geniculating; ventral surface of genital segment with a pulvilliform outgrowth terminating in two lateral projections .... A 1 ♂

A 1 ♀ Only 1 segment between the genital segment and the furca; furca with 3 bristles on either side .... *Thaumaleus* ♀

Two to 3 segments between genital segment and furca; furca with 5 to 6 bristles on either side .... *Monstrilla* ♀

A 1 ♂ Two segments between the genital segment and the furca; furca with 3 to 4 bristles on either side .... *Thaumaleus* ♂

Three segments between the genital segment and the furca; furca with 5 to 6 bristles on either side .... *Monstrilla* ♂

A 2. Cephalothorax with 5 pairs of feet, the last of which is of variable structure and sometimes reduced to 1 or 2 joints. First abdominal segment without foot rudiments. Posterior antennæ biramous, their outer ramus with at least 5 joints; both rami with plumose or hooked bristles (*Gymnoplea* in part) .... A 3

Cephalothorax with 4 pairs of feet. First (short) abdominal segment with rudiments of feet, which are inserted laterally or ventrally as paired (rod-, leaf-, or bristle-shaped) appendages. Posterior antennæ uni- or bi-ramous, in the latter case with at most 3-jointed, small, external ramus; tip of inner ramus with a few nonplumose, curved or hook-shaped bristles (*Amphartharandria* in part) .... *Isokerandria* A 13

A 3. On right or left sides of first thoracic segment in antero-lateral corner is a small brown knob .... *Pleuromma*

With no such knob .... A 4

A 4. First joint of inner ramus of the second foot with proximally curved hooks along the inner edge .... * *Metridia*

First joint of inner ramus of second foot normal, resembling corresponding joint in other feet .... A 5

A 5. Third joint of outer ramus of second to fourth foot with 2 spines on external border, the distal one inserted on tip of border; terminal bristle of joint with broad, smooth edge.... **Calanus*

Third joint of outer ramus of second to fourth foot with 3 spines on outer border, the distal one of which is inserted at tip of border; terminal bristle of joint denticulate (sometimes faintly) on its outer edge .... A 6

The 3 spines on outer margin of third joint of outer ramus of second to fourth foot and the denticulation of terminal bristle obsolete .... *Augaptilus* (in part).

A 6. One bristle of left limb of furca much longer and thicker than other bristles of furca...... A 7

Furcal bristles symmetrical .... A 8

A 7. Mandibular blade with 3 or 4 teeth, of which the ventral one is uncinate and separated from others by a long diastema; inner ramus of maxilla rudimental .... *Heterochæta*

Mandibular blade with at least 8 teeth; inner ramus of maxilla well developed .... *Disseta*

A 8. Abdomen with 3 to 4 segments; first segment with genital opening on its convex ventral surface. Anterior antennæ symmetrical .... A 8 ♀

Abdomen with 5 segments (anal segment, however, sometimes obsolete); its first segment with lateral genital opening. One of anterior antennæ a geniculating prehensile organ.... A 8 ♂

A 8 ♀ Inner and outer rami of fifth foot 3-jointed .... A 9 ♀

Inner and outer rami of fifth foot 2-jointed .... *Augaptilus* (in part)

Outer ramus of fifth foot 3-jointed, inner ramus 2-jointed .... *Isochæta* ♀

Outer ramus of fifth foot 3-jointed, inner ramus 1-jointed .... *Isias* ♀

Outer ramus of fifth foot 3-jointed, inner ramus lacking .... *Phyllopus* ♀

A 9 ♀ Second joint of outer ramus of fifth foot with a stout, thorn-like process on its inner border; third joint with 4 inner and 1 terminal bristle; third joint of inner ramus of fifth foot with 6 bristles .... **Centropages* ♀

Second joint of outer ramus of fifth foot with a thin, awl-shaped inner bristle; third joint of same with 3 inner and one terminal bristle; third joint of inner ramus of the fifth foot with 5 bristles .... *Leuckartia* ♀

Second joint of outer ramus of fifth foot with a thin, awl-shaped, or very rudimental inner bristle; third joint of same with 3 inner and 1 terminal bristle; third joint of inner ramus of fifth foot with at least 6 bristles .... A 10 ♀

A 10 ♀ Abdomen with 4 segments; inner ramus of maxilla at least 1-jointed .... *Hemicalanus* ♀

Abdomen with 3 segments; inner ramus of maxilla lacking .... *Augaptilus* ♀

A 8 ♂ Right anterior antenna prehensile .... A 9 ♂

Left anterior antenna prehensile .... A 11 ♂

A 9 ♂ Both inner rami of fifth pair of feet 3-jointed, provided with plumose bristles.......... A 10 ♂

Inner rami of fifth pair of feet rudimental, altogether without plumose bristles .... *Isias* ♂

A 10 ♂ Outer rami of fifth pair of feet differing in structure, the right provided with forceps, the left 2-jointed; mandibular blade richly dentate .... **Centropages* ♂

Outer rami of fifth pair of feet of similar structure; mandibular blade with few teeth .... *Augaptilus* ♂

A 11 ♂ Outer and inner rami of left fifth foot 3, of right 2-jointed .... *Leuckartia* ♂

Both outer rami of fifth pair of feet 3-jointed, the inner rudimental, mamilliform... *Arietellus* ♂

Both inner and outer rami of fifth pair of feet 3-jointed .... A 12 ♂

A 12 ♂ Inner ramus of maxilla at least 1-jointed; distal bristles of anterior maxillipeds provided with points or naked .... *Hemicalanus* ♂

Inner ramus of maxilla lacking; distal bristles of anterior maxillipeds with fungiform appendages .... *Augaptilus* ♂

A 13. Head with 2 large chitinous lenses, usually on edge of front, but sometimes shifted to ventral surface of the head (*Corycæidæ*) .... A 14

Head without chitinous lenses .... A 17

A 14. Inner ramus of fourth foot (2- or) 3-jointed .... A 15

Inner ramus of fourth foot 1-jointed or bristle-shaped .... A 16

A 15. Abdomen with 4 or 5 segments, which are laterally dilated .... **Sapphirina*

Abdomen with 2 segments, which are not broadened .... *Corina* ♀

A 16. Eye lenses separated by a distance at least equal to their diameter; two last cephalothoracic segments without lateral projections, the last with a median dorsal spine .... *Copilia* ♀

Eye lenses close together; two last cephalothoracic segments prolonged into pointed lateral projections, last without a dorsal spine .... **Corycæus*

A 17. Cephalothorax and abdomen flattened, leaf-shaped; mandibles, maxillæ and anterior maxillipeds lacking or reduced to minute stumps; furca very long and rod-shaped .... *Copilia* ♂
Cephalothorax of varying form, rounder or sometimes depressed in cross section, but never leaf-shaped; cephalic appendages all present; furca shorter, at most 6 times as long as broad..A 18
A 18. Outer ramus of first foot 1-jointed; posterolateral corners of the four cephalothoracic segments and front drawn out into processes .... *Clytemnestra*
Outer ramus of first foot 2 to 3-jointed .... A 19
A 19. Outer ramus of posterior antennæ 1-jointed; furca very short, on either side with 1 very long bristle (at least twice as long as trunk); limbs of furca and the 2 bristles fused in median line; remaining furcal bristles obsolescent........ *Ægisthus* ♀
Outer ramus of posterior antennæ 3-jointed, thin; furca short, with separate limbs and on either side with one long bristle, at least as long as trunk and at least twice as long as any of remaining bristles........ **Microsetella*
Outer ramus of posterior antennæ lacking; furca longer than broad, with separate limbs..A 20
A 20. Anterior and posterior maxillipeds of similar structure, both of them provided with long prickly bristles .... **Oithona*
Posterior maxilliped with few (or no) short bristles and a terminal hook (*Oncæidæ*) ....A 21
A 21. Fifth pair of feet 1-jointed, each terminating in 2 lanceolate appendages, which are provided with denticulate edges; cephalothorax long and slender .... *Lubbockia*
Fifth pair of feet 2-jointed, 1-jointed, or button-shaped, provided with naked or plumose bristles; cephalothorax less slender .... A 22
A 22. Anterior antennæ with very long and robust æsthetasks (sense hairs) on terminal joint; fifth pair of feet 2-jointed........ *Ratania* ♀
Anterior antennæ with numerous penicillate æsthetasks on proximal joints; fifth pair of feet papillate; cephalothorax robust, pear-shaped .... *Pachysoma*
Anterior antennæ with few and very delicate æsthetasks; fifth pair of feet small rods or knobs, sometimes reduced to a pair of bristles .... A 23
A 23. Hooked bristles on terminal joint of posterior antennæ of medium length; inner ramus of posterior feet at least as long as the outer ramus, its terminal joint in the fourth pair at least 1½ times as long as first and second together........ * *Oncæa*
Hooked bristles on elongated terminal joint of posterior antennæ very long; inner ramus of posterior feet shorter than outer ramus, its terminal joint in fourth pair not longer than either of the two proximal joints .... *Conæa*
B. Head without dorsal chitinous lenses or lateral hooks........ B 1
Head with 1 or 2 pairs of chitinous lenses and hook on either side of lateral border........ B 3
B 1. Posterior maxilliped 4-jointed; mandible with the rudimental outer ramus articulating proximally before the middle of second basal joint; rami of the posterior antennæ of nearly equal length .... *Parapontella*
Posterior maxilliped 5 to 7-jointed; mandibular rami articulating with second basal joint at about same level; outer ramus of posterior antennæ much shorter than inner ramus........B 2
B 2. Abdomen with asymmetrical protuberances .... **Monops*
Abdomen symmetrical (except in fusion of right furcal limb with anal segment in the female)........ *Pontellina*
B 3. Head with one pair of dorsal eye lenses; base of rostrum with lenticular thickening ....* *Ponte*
Head with two pairs of dorsal eye lenses; the base of the rostrum without lenticular thickening .... * *Anomalocera*
C. Posterior antennæ biramous; outer ramus with several joints; first abdominal segment without rudiments of feet; anterior antennæ at least 15-jointed (*Gymnoplea* in part) .... C 1
Posterior antennæ either uni- or bi-ramous; in the latter case with small, 1-jointed outer ramus; first abdominal segment with rudimental (rod- or leaf-shaped) feet; anterior antennæ at most 9-jointed. (*Ampharthrandia* in part) .... C 7
C 1. Both feet of fifth pair biramous, rami 2- or 3-jointed........ *Leuckartia*
Fifth pair of feet absent, or, if present, not more than left foot biramous........ C 2
C 2. Furca long and narrow, at least 6 times as long as broad; terminal bristle of third joint of outer ramus of second to fourth foot denticulate........ * *Temora*
Furca, at most, 3 times as long as broad; terminal bristle of third joint of outer ramus of second to fourth foot with a smooth border........ C 3

C 3. In third and fourth foot the second joint of inner ramus has 2, the third joint 7 bristles; scapelliform terminal bristle of third joint of outer ramus in second to fourth foot much broader than in first pair .... C 4

In third and fourth foot the second joint of inner ramus has 1, the third joint 5 bristles; scalpelliform terminal bristle of third joint of outer ramus in the first foot similar to that of second to fourth foot .... C 6

C 4. Second joint of inner ramus of first foot without an inner marginal bristle; outer border of outer ramus not denticulate; terminal joint of inner ramus of first foot with 4 bristles; (female: abdomen with 2 or 3 segments; fifth foot 3 or 4-jointed; terminal joint of anterior antennæ at least twice as long as penultimate joint) .... * *Calocalanus*

Second joint of inner ramus of first foot with an inner marginal bristle; outer border of outer ramus in more posterior feet denticulate; terminal joint of inner ramus of first foot with 5 bristles; (female: abdomen with 4 segments; fifth foot 2-jointed to lacking; terminal joint of anterior antennæ, at most, $1\frac{1}{2}$ times as long as penultimate joint) .... C 5

C 5. Third and fourth foot with denticulate outer border to the second joint of the outer ramus and to the proximal portion of the outer border in the third joint of the outer ramus; scalpelliform terminal bristle of the outer ramus of third foot little more than half as long as the third joint of the outer ramus; third joint of inner ramus of second foot with 6 bristles (female: fifth pair absent or knob-shaped; male: right fifth foot absent) .... *Acrocalanus*

Third and fourth foot denticulate only on proximal portion of third joint of outer ramus; not on second joint; scalpelliform terminal bristle of outer ramus of third foot longer than third joint of the outer ramus; third joint of inner ramus of second foot with 7 bristles; (female: fifth foot 2-jointed; male: fifth foot 2-jointed) .... * *Paracalanus*

C 6. Outer ramus of first foot 3-jointed; thorax without prickles (female: fifth foot wanting; male: neither foot of fifth pair biramous; right fifth foot sometimes wanting) .... * *Eucalanus*

Outer ramus of first foot 2-jointed; middle thoracic segments with 1 or 2 pairs of prickles; (female: fifth foot 3-jointed; male: fifth foot 2-jointed) .... *Rhincalanus*

C 7. Front with 2 large chitinous lenses .... * *Miracia*

Front without chitinous lenses .... C 8

C 8. Front conical, rounded anteriorly; cephalothorax very narrow; outer ramus of posterior antennæ wanting .... *Setella*

Front pointed; cephalothorax broader; outer ramus of posterior antennæ 1-jointed .... C 9

C 9. Furca with separate limbs (about twice as long as broad) and bristles much shorter than cephalothorax .... *Euterpe*

Limbs of the very short furca as well as their two unusually long bristles fused in the middle line .... *Ægisthus*

D. Head with dorsal eye-lenses; (posterior maxilliped 6-jointed, 6th joint very minute) ... * *Labidocera*

Head without dorsal eye-lenses .... D 1

D 1. Fifth pair of feet biramous with jointed inner ramus .... * *Centropages*

Fifth pair of feet uniramous .... D 2

D 2. Posterior maxilliped 7-jointed .... D 3

Posterior maxilliped 3- to 4-jointed .... D 5

D 3. Furca long and slender, at least 6 times as long as broad; posterior maxilliped twice as long as anterior .... * *Temora*

Furca at most 4 times as long as broad; posterior maxilliped shorter than anterior .... D 4

D 4. Anterior maxilliped with short bristles on its proximal, and long, thick, sickle-shaped bristles on its distal portion, proximal basal joint of posterior maxilliped with a few short bristles .... * *Candace*

Proximal and distal portions of anterior maxilliped and also proximal basal joint of the posterior maxilliped with long, prickly bristles .... *Calanopia*

D 5. Outer ramus of posterior antennæ shorter than distal joint of the inner ramus; anterior maxilliped provided on its proximal and distal portions with long, prickly bristles ... * *Acartia*

Outer ramus of posterior antennæ longer than distal joint of inner ramus; anterior maxilliped with short bristles on proximal and powerful hooked bristles on distal part .... * *Corynura*

E. Third joint of outer ramus of 2d to 4th foot with 5 inner marginal bristles .... *Spinocalanus* ♀

Third joint of outer ramus of 2d to 4th foot with 4 inner marginal bristles .... E 1

E 1. Surfaces of rami of second to fourth pairs of feet without larger spines; appendages of anterior maxilliped bristle-shaped .... E 2

Surfaces of outer ramus and especially of the second and third joints of the inner ramus of the third and fourth pairs of feet armed with stout spines; distal bristles of the anterior maxillipeds in part soft, vermiform or penicillate .... E 7 (*a*, *b*)

E 2. Second and third foot differing from fourth as follows: Basal joints and outer ramus broader and stouter, distal edge of second basal joint notched on posterior surface; terminal bristle (especially on third foot) with broader margin .... * *Clausocalanus*

Second and third foot not differing from fourth in above-mentioned particulars .... E 3

E 3. Outer marginal spines of second and third joints of outer ramus in fourth foot pectinate, lying in deep notches .... *Ctenocalanus*

Outer marginal spines of outer rami of feet of usual form .... E 4

E 4. Abdomen of 4 segments; its first segment with genital orifice on convex ventral surface, longer than the succeeding segments; fifth pair of feet symmetrical or wanting .... E 4 ♀

Abdomen of 5 segments; its first segment with genital orifice on left side, shorter than next following segments; fifth pair of feet asymmetrical .... E 4 ♂

E 4 ♀ On the antero-dorsal surface of head there is a median spine pointing forward; lateral portions of last thoracic segment prolonged on either side into a powerful point .... *Gaëtanus* ♀

Head without a median spine; lateral portions of last thoracic segment rounded or at most (on one side) with a short point .... E 5 ♀

E 5 ♀ Fifth pair of feet 2-jointed, terminating in a stout, curved, denticulate bristle .... E 6 ♀

Fifth pair of feet wanting .... *Pseudocalanus* ♀

E 6 ♀ Rostrum ending in two flaccid threads; last thoracic and genital segment symmetrical; first joint of outer ramus of first foot with external bristle; terminal bristle of fifth foot much longer than the two joints of the same taken together .... *Drepanopus* ♀

Rostrum wanting; last thoracic and genital segment asymmetrical; first joint of outer ramus of first foot without external bristle; terminal bristle of fifth foot about as long as the two joints of same taken together .... *Mœbianus* ♀

E 4 ♂ Feet of fifth pair, especially swollen left one, with a considerable number of peculiarly shaped appendages at its tip .... *Mœbianus* ♂

Feet of fifth pair long and slender, stylet-shaped .... *Pseudocalanus* ♂

Feet of fifth pair short, right one with uncinate terminal joint .... *Drepanopus* ♂

E 7(*a*). Outer ramus of posterior antenna more than 1½ times as long as inner ramus; cephalothorax globose in the female, and stout even in male (fifth pair of feet wanting in the female; in the male there are two uniramous feet) .... *Phaënna*

Outer ramus of posterior antenna less than 1½ times as long as inner ramus; cephalothorax elliptical .... E 8(*a*)

E 8(*a*). Surfaces (especially posterior surface) of the second and third joints of outer ramus of second (and fourth) foot armed with groups of small points; second joint of outer ramus of fourth foot without lamellæ; fifth foot of female wanting or 1 or 2 jointed; not denticulate on inner margin; female with well-developed right and 1-jointed inner ramus in left fifth foot .... *Scolecithrix*

Surfaces of outer ramus of second (and third) foot naked; second joint of outer ramus of fourth foot on posterior surface with a series of delicate lamellæ; fifth foot of female 2 or 3 jointed, denticulate on inner margin of the first joint; male with uniramous left and lacking right fifth foot .... *Xanthocalanus*

E 7(*b*). Twenty-fifth joint of anterior antenna fused with twenty-fourth .... *Scolecithrix*

Twenty-fifth joint of anterior antenna separate from the twenty-fourth .... E 8(*b*)

E 8(*b*). Fifth pair of feet wanting in female and consisting of two uniramous feet in male.. *Phaënna*.

Fifth pair of feet 2 or 3-jointed on either side in female; in male reduced to a single foot (the left) .... *Xanthocalanus*

F. Abdomen of 4 segments; its first segment (with the genital opening on the convex ventral surface which is often provided with protuberances) at least as long as the following and longer than its last segment; fifth pair of feet wanting; mouth parts well developed .... F ♀

Abdomen of 5 segments (with very short, concealed, anal segment), its first segment with genital opening on left side, shorter than the next succeeding segments; fifth pair of feet asymmetrical; blade of mandible, anterior maxilliped, and in part also the maxilla, obsolete .... F ♂

F ♀. Lateral corners of last thoracic segment each prolonged into a long-pointed process; outer ramus of first foot 3-jointed .... F 1 ♀

Lateral corners of last thoracic segment rounded, sometimes slightly pointed; outer ramus of first foot 2-jointed .... F 2 ♀

F 1 ♀. Rostrum ending in 2 stout, strongly chitinized prongs; rami of posterior antennæ of about same length .... *Aëtidius*

Rostrum wanting; inner ramus of posterior antennæ about half as long as outer ramus. *Chiridius.*

F 2 ♀. Rami of posterior antennæ of about the same length .... *Euchæta*

Outer ramus of posterior antennæ at least $1\frac{1}{2}$ times as long as inner ramus .... F 3 ♀

F 3 ♀. Inner border of first basal joint of fourth foot naked or with a few small hairs; median bristles of outer ramus of maxillæ shorter than the proximal and distal bristles .... *Undeuchæta*

Inner border of first basal joint of fourth foot with spinose or crenate bristles; median bristles of outer ramus of maxillæ not abbreviated .... *Euchirella*

F ♂. Only one foot of the fifth pair present and this is uniramous; lateral portions of last thoracic segment pointed .... *Aëtidius* ♂

Feet of fifth pair both powerfully developed; lateral portions of the last thoracic segment rounded .... F 1 ♂

F 1 ♂. Inner ramus of posterior antenna considerably shorter than outer ramus; right fifth foot chelate .... *Euchirella* ♂

Rami of posterior antennæ about same length; fifth foot not chelate, the right, sometimes also the left, bearing a stylet-shaped appendage .... *Euchæta.*

Suborder GYMNOPLEA.

Family CALANIDÆ.

CALANUS Leach.

Female: Head free or fused with first thoracic segment; fifth thoracic segment free, sometimes asymmetrical; rostrum ending in two points; abdomen composed of 4 segments; genital segment symmetrical; furca occasionally slightly asymmetrical. Anterior antennæ sometimes not reaching hind end of body, sometimes extending a considerable distance beyond, and not always of symmetrical length, 25-jointed, with very uniformly distributed short antero-marginal bristles and delicate æsthetasks, and 2 long and plumose postero-marginal setæ on terminal joints. Rami of posterior antennæ of about equal length, outer ramus 7-jointed. Mandibular blade with 8 rather flat teeth; rami of about equal length, proximal joint of inner ramus with sack-shaped appendage. Maxillæ with 3-jointed inner ramus, articulating with basal; outer lobe with bristle. Anterior maxilliped relatively long, with long curved bristles on inner and a plumose bristle on outer margin. Posterior maxilliped with long 5-jointed inner ramus, provided with long, stiff, usually naked bristles.

Male: Abdomen composed of 5 segments; genital orifice sinistral; furcal bristles abbreviated. Anterior antennæ held in an unusual position and sometimes abbreviated, the number of their joints reduced (at least the first two joints fused), twenty-fifth joint usually abbreviated, æsthetasks enlarged and increased in number, bristles, with rare exceptions, reduced. Posterior antennæ stouter than in female, with in part abbreviated bristles; outer ramus with an S-shaped curvature. Mandibular blade weaker and in some species stunted; in these same forms the inner marginal appendages of maxillæ and of the anterior maxillipeds are decidedly stunted. In general a stronger development of outer marginal bristles at end of posterior maxilliped, which in some species are also stunted, owing to shortening, obliteration of joints, and absence of bristles. In some species differences as compared with the female are found also in separation of head from first thoracic segment, in form of last thoracic segment, and in the feet.

1. Calanus finmarchicus Gunner.

Female: Head separated from first thoracic segment; front and lateral portions of fifth thoracic segment rounded; furcal bristles symmetrical. Anterior antennæ reaching about to end of trunk; æsthetasks not duplicated on any joints. Distal margin of second basal joint of second to fourth pairs of legs with pointed projection; ratio of lengths of portions of outer margins of third joint of outer ramus in second to fourth pairs as 2:1; 2:1; 3:1. First basal of fifth pair with concave, denticulated inner border.

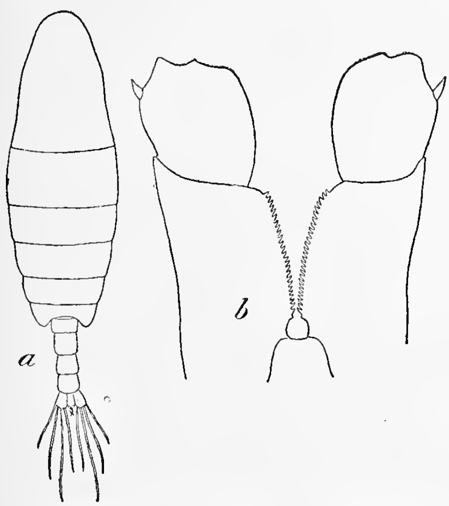
Male: Head separated from first thoracic segment. Anterior antennæ straight (joints 1 and 2 fused). Mouth parts similar to those of female (outer bristle of fourth joint of inner ramus of posterior

maxilliped reaching down about to distal edge of second basal). Right fifth foot has outer ramus without an internal bristle; terminal bristle thorn-shaped, sometimes denticulate; left fifth foot has inner ramus, as on right side; basal and first and second joints of outer ramus elongated, so that right outer ramus (exclusive of terminal bristle) reaches at least to middle, at most as far as end of second joint of left outer ramus; third joint of outer ramus abbreviated.

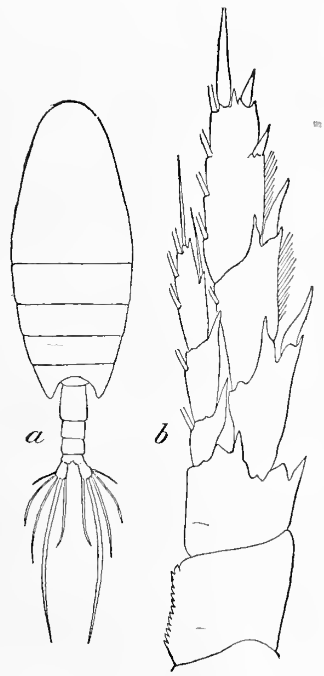
Coloration: Rather transparent, with rather irregularly distributed red pigment in body and sometimes in appendages. In some individuals color is lacking except in anal region. Eggs yellowish or reddish.

Length of female, 2.7 to 4.5 mm; of male, 2.35 to 3.2 mm.

Numerous colorless female specimens of this thoroughly pelagic, widespread, and economically very important species were taken in the tow by the *Fish Hawk* in Vineyard Sound, near Gay Head,



1. *Calanus finmarchicus* Gunner: *a*, female, dorsal aspect; *b*, basal portion of fifth pair of legs.



2. *Calanus minor* Claus; *a*, female, dorsal aspect; *b*, female, fifth foot.

Marthas Vineyard, July 10. My specimens do not show a marked concavity of inner border of basal joints of fifth pair of legs, but in other respects they conform with Giesbrecht's description.

2. Calanus minor Claus.

Female: Head and first thoracic segment united; front and lateral portions of fifth thoracic segment rounded; furcal bristles symmetrical, the longest twice as long as abdomen and twice as thick as other bristles. Anterior antennæ not reaching to posterior end of trunk; æsthetasks not duplicated on any joints. Distal margin of second basal joint of second to fourth pairs with pointed projection; ratios of lengths of pieces of third joint of outer ramus as 5:4; 10:7; 2:1. First basal joint of fifth pair of feet along inner border with straight margin, less finely denticulated than in *C. finmarchicus*.

Male: Head and first thoracic segment fused. Anterior antennæ curved (joints 1 and 2, 3 to 5, 24 and 25 fused). Mouth parts similar to those of female (outer bristle of fourth joint of inner ramus of posterior maxillipeds extending down nearly to distal edge of second basal). Right fifth foot has third joint of outer ramus with only 2 inner bristles and a short, thorn-shaped terminal bristle; left fifth foot with only 3 small bristles on third joint of inner ramus.

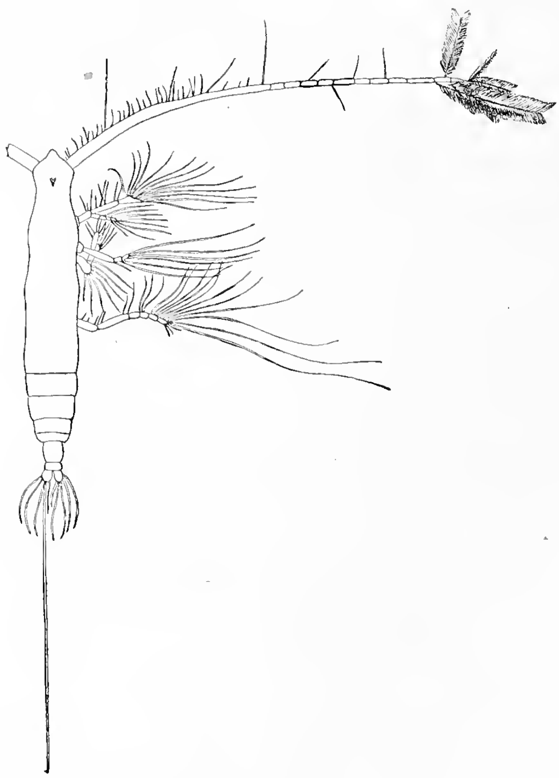
Length of female, 1.8 to 2 mm.; of male, 1.7 to 1.8 mm.

Numerous female specimens taken in Gulf Stream tow, July 25, 1899. This species has a very wide range of distribution.

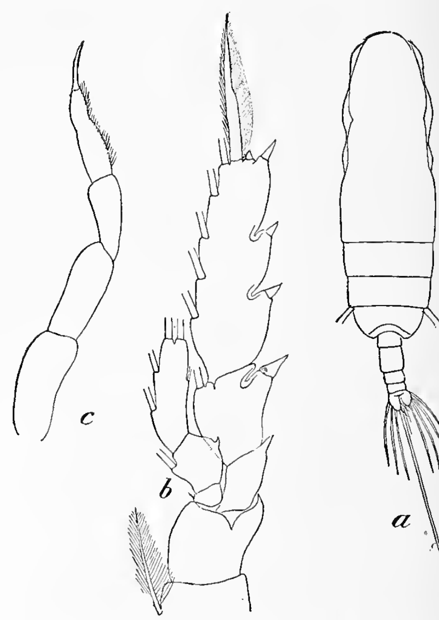
EUCALANUS Dana.

Anal segment and furca fused; furca asymmetrical. Mandible of female longer than maxilla and more than two-thirds as long as fourth pair of feet; its second basal joint forms with outer ramus a cylindrical body, with which the very small inner ramus articulates much further proximally than outer ramus. Inner ramus of posterior maxillipeds longer than first or second basal joint. First pair of feet with 3-jointed outer and 2-jointed inner ramus. Fifth pair of feet wanting in female; in male both of these feet are uniramous, the left 4-jointed, the right 1 to 4 jointed or lacking.

Female: Trunk usually elongated; head fused with first thoracic segment, two last thoracic segments less intimately united; head triangular, often elongated, with transverse dorsal furrow; rostrum ending in thin threads; abdomen short, with 3 or 4 segments; genital segment symmetrical; anterior antennæ reaching beyond end of body, sometimes of asymmetrical lengths, 23-jointed, owing to fusion of first and second and of eighth and ninth joints; the first joint elongated, the last



3. *Eucalanus attenuatus* Dana; female; dorsal aspect. After Giesbrecht.



4. *Eucalanus monachus* Giesbrecht male; *a*, dorsal aspect; *b*, fourth foot; *c*, left fifth foot.

joint longer than penultimate; æsthetasks long and delicate; bristles usually plumose, those of terminal joints in part with long and sometimes gorgeously colored plumes; inner ramus of posterior antennæ longer than outer ramus, sometimes more than twice as long, the latter 7 or 8 jointed; proximal outer marginal lobe of maxillæ strongly projecting, second basal joint elongate, inner ramus distinctly jointed, outer ramus relatively small; anterior maxilliped with a long, plumose outer marginal bristle; inner ramus of posterior maxilliped relatively long and provided with long bristles; feet short, outer ramus 3-jointed; inner ramus of first pair 2-jointed, of remaining pairs 3-jointed.

Male: Trunk shortened; peculiarities in form of head of female not apparent; abdomen of 5 segments; furca and furcal bristles similar to those of female; first 2 joints of anterior antennæ separate, terminal joint abbreviated; bristles abbreviated, with rudimental plumes; æsthetasks enlarged and increased in number; posterior antennæ stouter than in female, part of bristles absent; mandibular

blade in some species slightly, in others considerably, reduced; second basal joint shortened, inner ramus inserted nearer end of joints; appendages of inner border of maxillæ and of anterior maxilliped not generally reduced; modification of posterior maxillipeds like that of *Calanus.*

3. Eucalanus attenuatus Dana.

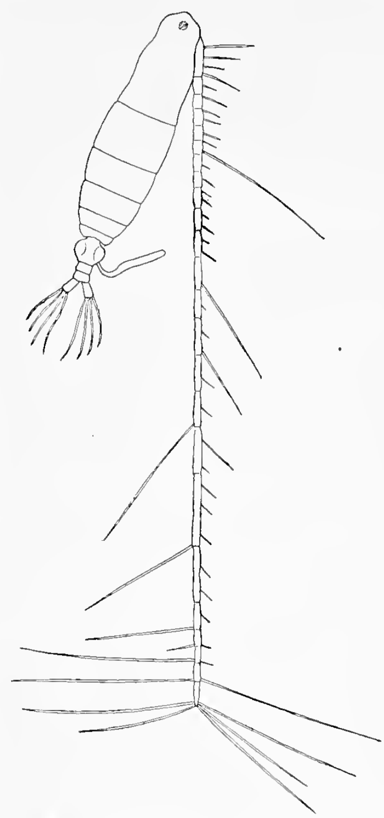
Female: Only one segment between genital and anal segments; front triangular, indented on either side, tapering decidedly; genital segment longer than broad; furca and second terminal bristle asymmetrical; first and second joints of outer ramus of posterior antennæ separated; inner ramus $1\frac{1}{3}$ times as long as second joint of inner ramus and four times as long as broad; second basal of mandibles with 2 inner marginal bristles; tip of inner ramus not reaching distal edge of second basal joint by more than length of ramus; first joint of inner ramus without bristles, second joint with 4 bristles; second inner lobe of maxillæ present; third inner lobe with 4 bristles, second basal joint with 5 bristles. Posterior maxilliped has first joint of inner ramus with 3 bristles, third joint with 4 bristles.

Male: Pronounced secondary sexual characters; right fifth foot present, left much shorter than the fourth foot.

Coloration: Transparent, with a variable amount of red pigment in body and often in some of basal joints of anterior antennæ and proximal terminal joints of appendages; terminal plumes of anterior antennæ colorless, or red, with iridescence.

Length of female, 4.2 to 4.85 mm.; of male, 3.1 to 3.25 mm.

A single female specimen taken in the Gulf Stream tow July 25, 1899. The plumes at the tip of the anterior antennæ are much damaged, but there can be no doubt of the specific identity. In life the translucent body contains more or less bright-red pigment, irregularly and often asymmetrically distributed. In my specimen the antennal plumes are colorless, at least in part, but in specimens studied by Giesbrecht they were sometimes bright orange with blue or violet iridescence.



5. *Mecynocera clausii* Thompson; female; dorsal aspect.

4. Eucalanus monachus Giesbrecht.

Female: Only one segment between genital and anal segments; genital segment somewhat broader than long; asymmetry of furca slight; first and second joints of outer ramus of posterior antennæ fused; first joint of inner ramus shorter than second and about twice as long as broad; second basal joint of mandibles with 3 inner marginal bristles; inner ramus almost reaching dorsal margins of second basal joint; first joint of inner ramus with 2, second with 4 bristles; second inner lobe of maxilla lacking, third inner lobe with 3 bristles, second basal with 4 bristles; first and second joints of the inner ramus of posterior maxilliped each with 3 bristles.

Male: Less pronounced secondary sexual characters; right fifth foot wanting.

Length of male, 2.13 to 2.35 mm.; of female, 2.2 mm.

A single male specimen taken in Gulf Stream July 25, 1899. Hitherto this species has only been taken at Gibraltar (Giesbrecht, 1888).

MECYNOCERA J. C. Thompson.

Furca symmetrical, articulating with anal segment; mandible shorter than maxilla and less than half as long as fourth pair of feet; its structure similar to that of *Calanus*, but inner ramus is nearly as long as second basal and twice as long as outer ramus; inner ramus of posterior maxillipeds at least as long as first or second basal; first pair of feet with 3-jointed outer and 1-jointed inner ramus; fifth pair of feet present, on either side 5-jointed.

Male: Unknown.

Female: Head distinct from thorax; rostral threads delicate; abdomen short, with 3 segments; genital segment and furca symmetrical; anterior antennæ of asymmetrical length, more than twice as long as the body, 23-jointed, with a few very long bristles; inner ramus of posterior antennæ nearly twice as long as outer ramus; the succeeding appendages similar to those of *Calanus;* feet short; outer rami 3-jointed, inner ramus of first pair 1-jointed, of second to fourth pairs 3-jointed; fifth pair of feet with 2-jointed basals and 3-jointed outer rami, without inner rami.

5. Mecynocera clausii J. C. Thompson.

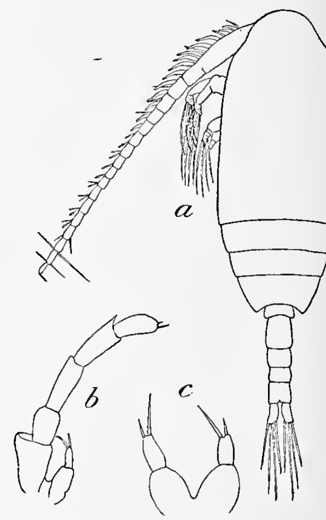
The only species of this genus; very transparent, colorless, or with a few red spots. In exceptional cases the bristles of furca and of anterior antennæ are red. Length, 0.92 to 1 mm. A single specimen was taken in the Gulf Stream July 25, 1899; the male is unknown. Thompson took the species near the Canary Islands and at Malta. Giesbrecht gives the following localities: Naples; Pacific Ocean, to 138° W., between 3° S. and 15° N., from surface to a depth of 1,000 meters.

PARACALANUS Bœck.

Second basal joint of first pair of feet with an inner marginal bristle; proximal portion of outer margin of third joint of outer ramus in fourth pair of feet more than twice as long as distal portion; outer margin of second joint not denticulate; proximal portion of outer margin of third joint of outer ramus in third and fourth pairs denticulate; scalpelliform terminal bristle of outer ramus in third pair longer than end joint; second joint of inner ramus of first pair with 5 bristles; third joint of inner ramus of second pair with 7 bristles; abdomen of female with 4 segments; last joint of anterior antennæ less than 1½ times as long as penultimate joint; fifth foot short, 2-jointed; right fifth foot of male 2-jointed, left 5-jointed.

Female: Head fused with first thoracic segment and fourth fused with fifth thoracic segment; rostrum ending in two flaccid threads; genital segment and furca symmetrical, the latter without an outer marginal bristle; anterior antennæ 25-jointed, with obliterated separation between first and second, also between eighth and ninth joints; outer ramus of posterior antennæ shorter than inner ramus; mandibles with broad blades; the sack-like appendage on first joint of inner ramus small; maxillæ with indistinct jointing of inner ramus, without a bristle on second outer marginal and with only one bristle on second inner marginal lobe; anterior maxilliped with an outer marginal bristle; inner ramus of first foot 2-jointed, of the second to fourth 3-jointed.

Male: Abdomen with 5 segments; number of joints in anterior antennæ reduced by fusion of first to sixth and of seventh with eighth; terminal joint abbreviated but separated; æsthetasks enlarged and increased in number; mandibular blade, appendages of inner margin of maxillæ and of anterior maxilliped, stunted; to a less extent also the posterior maxilliped, the outer bristle of which is long and densely plumose. Minor peculiarities are also exhibited by the feet.



6. *Paracalanus parvus* Claus; *a*, male, dorsal aspect; *b*, male, fifth pair of feet; *c*, female, fifth pair of feet.

6. Paracalanus parvus Claus.

Female: Inner bristle of furca scarcely longer than furca; anterior antennæ reaching to posterior edge of third abdominal segment; first joint of inner ramus of maxillæ with 2 bristles on anterior border; third lobe of first basal joint of posterior maxilliped with 2 bristles; inner margin of first basal of fourth pair of feet extending out into 1 or 2 points; anterior and posterior surfaces of first basal of second to fourth pairs of feet beset with hairs and points; surfaces of first and second joints of outer ramus of third pair and of second joint of inner ramus of fourth pair naked.

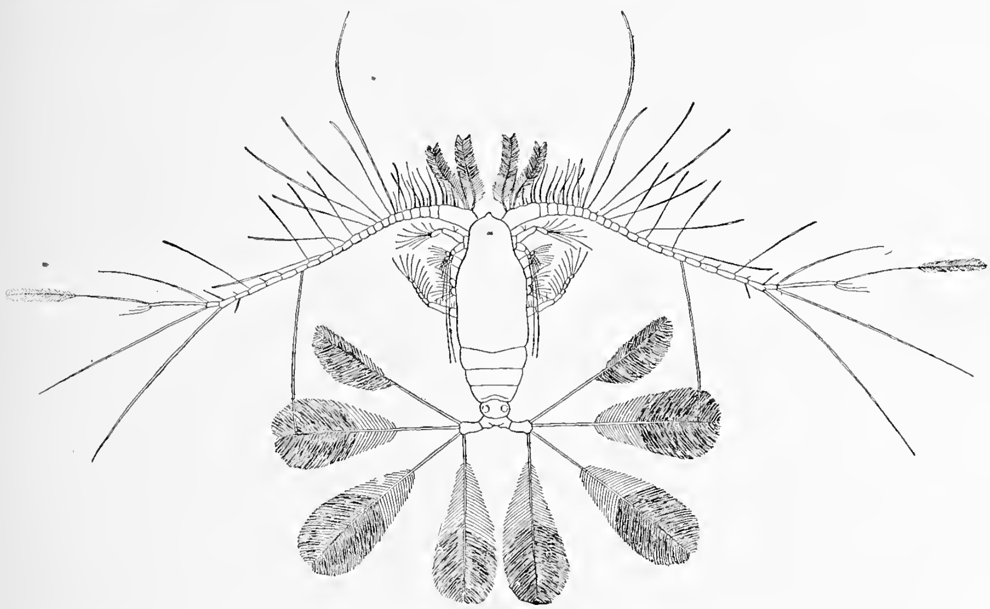
Male: Abdomen with very short genital segment; feet longer than in female; mouth parts abbreviated as in *Calocalanus;* æsthetasks present on some joints of anterior antennæ where they are lacking in female; they are not very large on distal portion of antennæ, but on joints 3 to 6 and 1 to 2 they have the form of rather thick, long, dependent sacs; the bristles are short; fifth pair of feet similar to that of *Calocalanus,* but right foot has only 2 joints.

Coloration: Rather transparent, with red pigment, variable in amount but never very abundant. Length of female, 0.8 to 1 mm.; of male, 0.91 to 1 mm.

Numerous specimens of this species were taken in the Gulf Stream at 6 a. m., July 29, 1899, about 70 miles south of Martha's Vineyard. This species has been frequently taken on the coasts of Europe and also in the Pacific Ocean (west of South America, between 10° and 55° S., 108° W., and at Hongkong), but its presence in the Western Atlantic has not been noted hitherto.

CALOCALANUS Giesbrecht.

First pair of feet without an inner marginal bristle on the second basal joint; the proximal portion of outer margin of last joint of outer ramus in fourth pair more than twice as long as distal portion; outer margin of outer rami not denticulate; terminal bristle of outer ramus in third pair longer than end joint; second joint of the inner ramus of first pair with 4 bristles; third joint of inner ramus of second pair with 7 bristles. Abdomen of female with 2 or 3 segments; last joint of anterior antennæ at least twice as long as penultimate joint. Fifth pair of feet of female 3 or 4 jointed; right fifth foot of male 4-jointed, left 5-jointed.



7. *Calocalanus pavo* Dana; female, dorsal aspect. After Giesbrecht.

Female: Head fused with thorax, fourth with fifth thoracic segment; rostrum terminating in soft filaments; abdomen short; furca sometimes asymmetrical, provided with gorgeously plumed setæ; antennæ extending beyond the end of body, 25-jointed, but with obliterated boundary between first and second and between eighth and ninth joints; many of the bristles long, pigmented or beautifully plumose. Posterior antennæ with rami of equal length, or with shorter outer ramus. Mandible with but slightly dilated blade and small, sac-shaped appendage on proximal joint of inner ramus; maxillæ and maxillipeds similar to those of *calanus;* inner ramus of first foot 2-jointed, of second to fourth foot 3-jointed.

Male: Head distinctly separated from first thoracic segment; abdomen with 5 segments, furcal bristles less richly plumose; anterior antennæ abbreviated; joints 1 and 2, 3 to 6, and 24 and 25 are fused, the twenty-fifth shortened; bristles reduced, æsthetasks powerfully developed. Peculiarities of succeeding appendages similar to those of *Paracalanus.*

7. Calocalanus pavo Dana.

Female: Abdomen with 2 segments; genital segment onion-shaped; furca and furcal bristles symmetrical. Terminal joint of anterior antennæ 5 times as long as penultimate and more than 7 times as long as twelfth joint. Outer ramus of posterior antennæ nine-tenths as long as inner ramus;

outermost terminal bristle of seventh joint of outer ramus more than 5 times as long as outer ramus. First basal joint of first pair of feet with inner marginal bristle; third joint of inner ramus of third and fourth pairs of feet each with a cluster of spines; proximal piece of outer border of third joint of outer ramus in fourth pair about twice as long as distal piece. Fifth pair of feet as long as basal of fourth pair.

Male: Separation between head and first thoracic segment more distinct than in female, whereas line of separation between fourth and fifth thoracic segments has disappeared. Abdomen consisting of 5 segments, of which third and fourth are shortest, the genital and anal segments longest. Furca smaller than in female, its bristles shorter and much less richly plumose. Feet much longer in proportion to trunk, especially to cephalothorax and posterior antennæ; maxillæ and maxillipeds much shorter than in female.

Coloration: Female very transparent, with orange or brick-red pigment not only in trunk but also in appendages, especially in long bristles of anterior antennæ and furca, and in broad plumes of latter, which have besides a metallic iridescence. These plumes can be spread, making Dana's specific name a very appropriate one. Male transparent, with bright-red anterior antennæ, antennal, mandibular, and furcal bristles.

Length: Female, 0.88 to 1.2 mm.; male, 1.04 mm.

Numerous female specimens with much-damaged furcal plumes were taken in Gulf Stream July 25, 1899, at 8 p. m. It is a truly tropical species hitherto known only from the following localities: 12° N. 24° W. (Dana) Western Pacific to 175° W., between 3° S. and 19° N. from the surface to a depth of 1,000 (4,000?) meters (Giesbrecht); Canary Islands; Malta (Thompson).

8. Calocalanus plumulosus Claus.

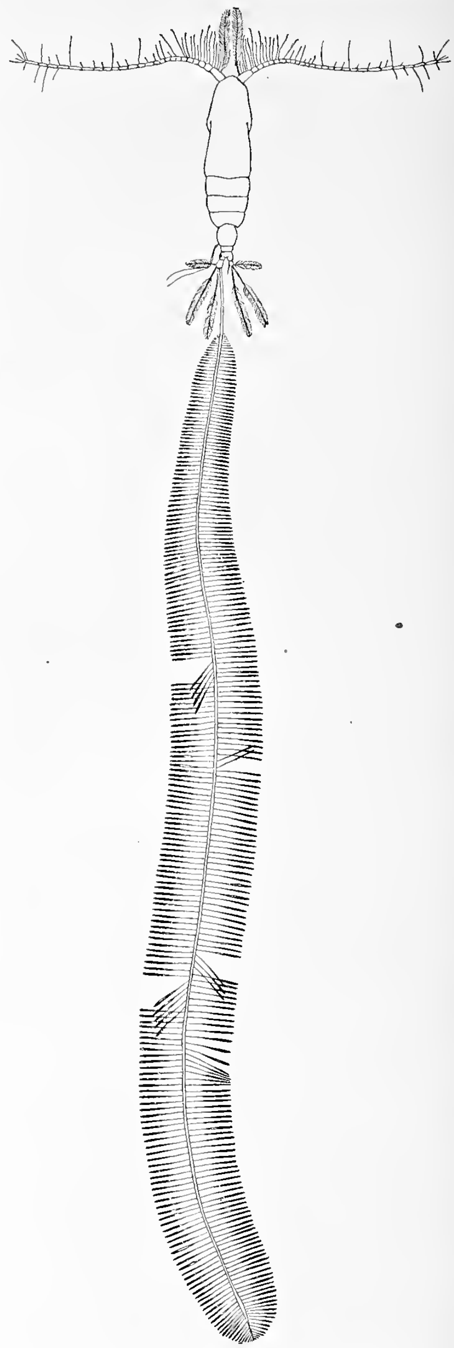
Female: Abdomen 3-jointed; genital segment cuboidal; furca and furcal bristles asymmetrical (left limb the larger of the two, fused with anal segment and furnished with an enormously long bristle). Terminal joint of anterior antennæ twice as long as penultimate and twelfth joint. Outer ramus of posterior antennæ five-sevenths as long as inner ramus; outermost terminal bristle of seventh joint of outer ramus but little longer than the others. First basal joint of first pair of feet with an inner marginal bristle; third joint of inner ramus of third pair with 2 groups, of fourth pair with 1 group of spines; proximal piece of outer border of third joint of outer ramus in fourth pair 4 times as long as distal piece. Fifth pair of feet considerably longer than basal of fourth pair.

Male: Unknown.

Coloration: Female transparent, with orange or brick-red pigment scattered through the body and in antennal and furcal plumes.

Length: 0.93 to 1.2 mm.

Several female specimens of this interesting form were taken in the tow with the preceding species.



8. *Calocalanus plumulosus* Claus; female, dorsal aspect. After Giesbrecht, with modifications.

In all specimens the greater portion of the huge furcal bristle had been broken off in the tow net, but

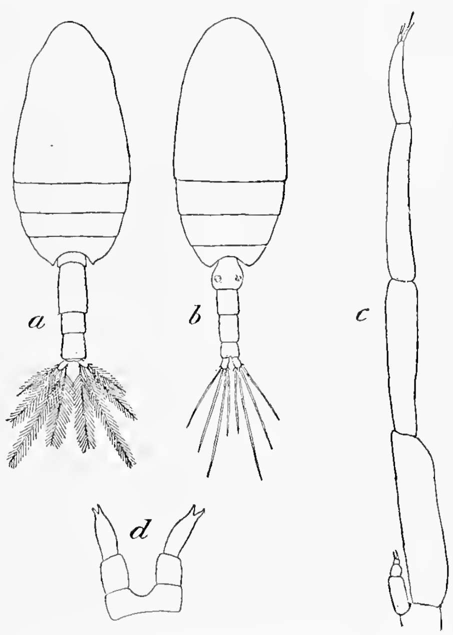
the other plumes were present. There could be no mistaking the specific identity of my specimens. It is known to occur in the Mediterranean (Claus and Giesbrecht) and in the Pacific Ocean 108° to 124° W. and 0° to 11° N. (Giesbrecht).

CLAUSOCALANUS Giesbrecht.

Rostrum ending in two points; terminal joint of anterior antennæ fused with penultimate joint; second and third pairs of feet with broad, calyculate basal joint, crenated on its distal border, and also with broad outer rami. Mouth parts of male much reduced, as is also the number of joints in anterior antennæ of the same sex.

Female: Head fused with first thoracic segment, fourth with the fifth thoracic segment; rostrum with 2 short, rather stiff filaments. Abdomen with 4 segments; genital segment and furca symmetrical. Anterior antennæ reaching beyond thorax, 23-jointed, eighth joint fused with ninth, twenty-fourth with the twenty-fifth; æsthetasks short, bristles of terminal joint elongated. Outer ramus of posterior antennæ $1\frac{1}{2}$ times as long as inner ramus; the former 6-jointed, with short bristles on the proximal joints. First joint of inner ramus of mandible, with a very short, sac-shaped appendage. Maxillæ and maxillipeds similar to those of *Calanus;* outer marginal bristle lacking in anterior maxilliped. Outer rami of third pair of feet, inner ramus of first pair 1-jointed, of second pair 2-jointed, of third and fourth pairs 3-jointed; terminal joint of outer ramus with finely denticulate terminal saw and 4 inner marginal bristles on the second to fourth pairs. Fifth pair of feet short, consisting of 2 uniramous, 3-jointed feet.

Male: Head and first thoracic segment fused, lengthened at expense of free thoracic rings; rostrum reduced; abdomen with 5 segments, of which the anal is very short. In anterior antennæ the first fuses with swollen second joint, the eighth to tenth, thirteenth to sixteenth, the twentieth and twenty-first; æsthetasks enlarged. Outer ramus of posterior antennæ more than twice as long as inner ramus. Mandibular blade, appendages of inner border of maxillæ, and anterior maxilliped stunted; this is less the case with posterior maxilliped, the outer marginal bristles of which are not enlarged. Feet elongated. Left foot of fifth pair long, uniramous and 5-jointed, right foot short and 1 to 3 jointed.



9. *Clausocalanus arcuicornis;* *a*, female, dorsal aspect; *b*, male, dorsal aspect; *c*, male, fifth pair of feet; *d*, female, fifth pair of feet.

9. Clausocalanus arcuicornis Dana.

Female: Genital segment longer than third or fourth abdominal segment; furca about as long as broad. No æsthetasks on joints 4, 6, 8, 18, 22 of anterior antennæ.

Male: Second abdominal segment as long as third and fourth segments together; right fifth foot 3-jointed.

Coloration: Not very transparent, with red pigment in some parts of thoracic segments, on dorsal and ventral surfaces and in genital segment. In male the pigment is on the whole more abundant and may extend into basal joints of anterior antennæ. In rare instances all the chitinous cuticle has a violet color. The eggs are rose-colored.

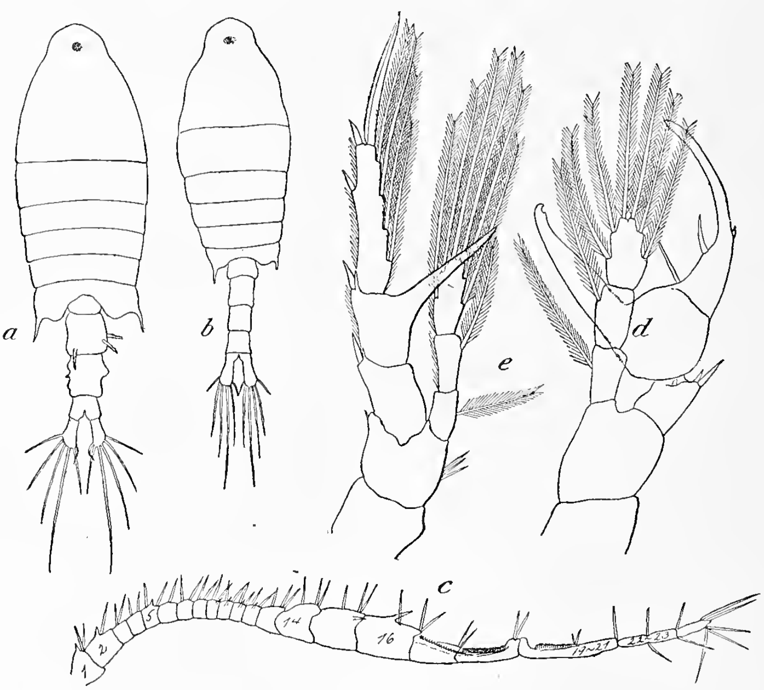
Length of female, 1.15 to 1.6 mm.; of male, 1.12 to 1.2 mm.

Three male and numerous female specimens were taken in the Gulf Stream July 29, 1899. The males all had the chitinous cuticle of a pale pellucid violet color.

Family CENTROPAGIDÆ.

CENTROPAGES Kröyer.

Female: Head separated from thorax and 4th from 5th thoracic segment; ventral eye sometimes protruding from ventral surface of head; abdomen with 3 segments, genital segment asymmetrical, Anterior antennæ 24-jointed (joints 24 and 25 fused); their appendages very complete; bristles naked, short and flaccid, with difficulty distinguishable from æsthetasks. Posterior antennæ similar in structure to those of *Calanus*, outer ramus 7-jointed, as much as $1\frac{1}{2}$ times as long as inner ramus. Also mandible and maxilla similar to those of *Calanus*, but in certain of species with fewer appendages. Distal bristles of anterior maxillipeds (those of the second basal joint and the inner ramus) hook-shaped, with spinose plumes, much thicker and longer than proximal bristles; lobes rather short. First basal joint of posterior maxillipeds with strongly projecting lobes and long bristles with spinose plumes on two median



10. *Centropages typicus* Kröyer; *a*, female, dorsal aspect; *b*, male, dorsal aspect; *c*, male, right anterior antenna; *d*, male, right fifth foot; *e*, female, fifth foot.

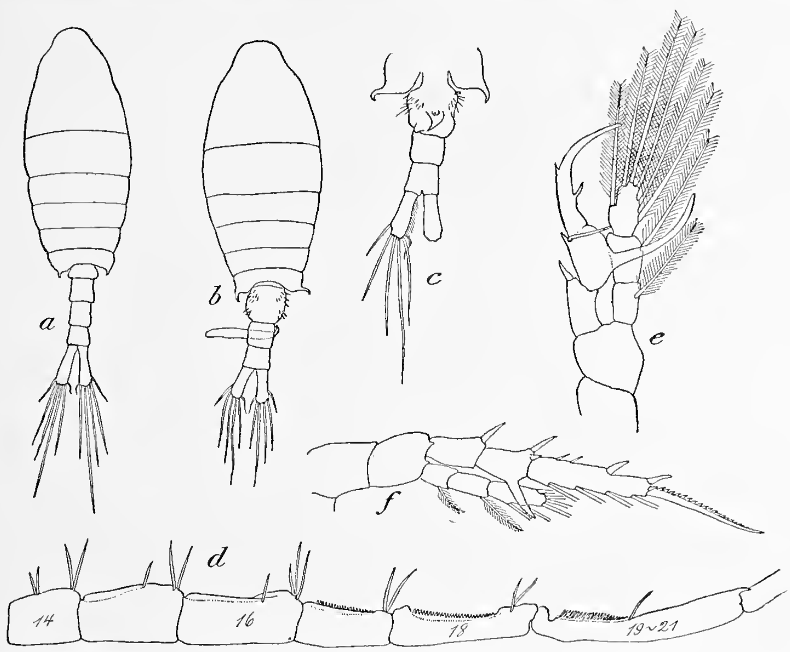
lobes; outer marginal bristles of the 5-jointed inner ramus well developed and plumose as in *Calanus*. Rami of all 5 pairs of feet 3-jointed (in exceptional cases the inner ramus is 2-jointed). First basal joint with an internal marginal bristle in first to fourth pairs of feet, second basal with such a bristle in the first pair. First basal of fifth pair without an internal marginal bristle; number of bristles on rami as follows: Outer marginal bristles of outer ramus in first pair, 1, 1, 2, inner marginal bristles 1, 1, 4; in the second to fourth pairs the outer marginal bristles are 1, 1, 3; the inner 1, 1, 5; in the fifth pair, outer marginal bristles 1, 1, 2; inner, 0, 1, 4; inner ramus with 0, 0, 1 outer, and 1, 2, 5 inner marginal bristles in first pair; 0, 0, 2 outer and 1, 2, 6 inner marginal bristles in second and third pairs; 0, 0, 2 outer, 1, 2, 5 inner marginal bristles in fourth pair, and 0, 0, 2 outer, 1, 1, 4 inner marginal bristles in fifth pair; the internal bristle of second joint of outer ramus in the fifth pair is thorn-like and fused with its joint.

Male: Sexual peculiarities in structure of abdomen, of right anterior antenna, in fifth pair of feet; to some extent also in fifth thoracic segment and third and fourth pairs of feet. Abdomen consisting of 5 segments, usually with a very short anal segment; genital orifice sinistral; right anterior antenna a prehensile organ, in which joints nineteenth to twenty-first and usually also twenty-second

to twenty-third are fnsed, the articnlation being between the eighteenth and nineteenth joint; in the outer ramus of left fifth foot the inner bristle is wanting, and second joint is fused with third, which sometimes bears awl-shaped appendages; outer ramns of right fifth foot remains 3-jointed, and its two terminal joints are modified to form a forceps, one limb of whieh is the terminal joint, the other the incrassated inner marginal bristle of the seeond joint.

10. Centropages typicus Kröyer.

Unpaired eye with ventral eonvexity; fifth thoraeie segment with lateral hooks, which are not qnite symmetrieal in male; anal segment of male obsolescent; outer fureal bristle short, inserted near tip of margin, not plumose in male, awl-shaped; genital segment of female with 4 thorn-like bristles; fourth abdominal segment with a knob-like swelling on right side; anterior antennæ exeeeding end of furea by about their last two joints; seeond joint sharply separated from first, at least twice as long as third; joints 3, 6, and 25 without proximal bristle; anterior margin of joints 1, 2 *b*, and 5 with a tooth. Outer ramus of posterior antennæ but little longer than inner. Rami of mandibles of abont equal length. Seeond outer lobe of maxilla with a small plumose bristle; seeond inner lobe pyriform, with 3 bristles; seeond basal joint with 5 bristles. First joint of inner ramns and third to fifth of posterior maxillipeds each with 2 marginal bristles; seeond joint of inner ramns with 3 inner marginal bristles. Prong of second joint of outer ramus in fifth foot of male robust, longer



11. *Centropages hamatus* Lilljeborg; *a*, male, dorsal aspect; *b*, female, dorsal aspect; *c*, female, ventral aspect of abdomen; *d*, male, fourteenth to twenty-first joints of right anterior antennæ; *e*, male, right fifth foot; *f*, female, fifth foot.

than joint, erect. Middle joints of male grasping antenna broad (joints 13 and 14 broader than long); anterior border of joint 15 with a small tooth, joint 16 with a larger tooth; second joint of right outer ramus of third and fourth foot in male with enlarged outer marginal bristle. Forceps of male grasping foot stout; distal hook longer than proximal; outer bristle on end joint of left onter ramus short.

Coloration: Not very transparent; with reddish-brown pigment variously distributed through the cephalothorax and abdomen, especially in neighborhood of mouth and insertions of posterior feet (also in the grasping antenna).

Length of female, 1.6 to 2 mm.; of male, 1.42 to 1.85 mm.

This speeies is nearly always present in small numbers in the tow taken from the Fish Commission's wharf at Woods Hole and in the neighboring Vineyard Sonnd. Very abundant in tow from Plymonth Harbor and from the Gulf Stream 70 miles south of Marthas Vineyard. In the latter tow the specimens were full of a dark blackish-blue pigment.

11. Centropages hamatus Lilljeborg.

No teeth on joints 1, 2, 5, 15, and 16 of anterior antennæ; lateral corners of last thoracic segment terminating in hooks, asymmetrical in the female. Inner ramus of first to third pairs of feet 3-jointed; inner marginal bristle of first joint of inner ramus of fifth foot in female a normal plumose bristle; outer marginal bristle of second joint of outer ramus of fourth foot in male symmetrical. A spine in front of genital orifice.

Length of female, 1.3 to 1.42 mm.; of male, 1.15 to 1.3 mm.

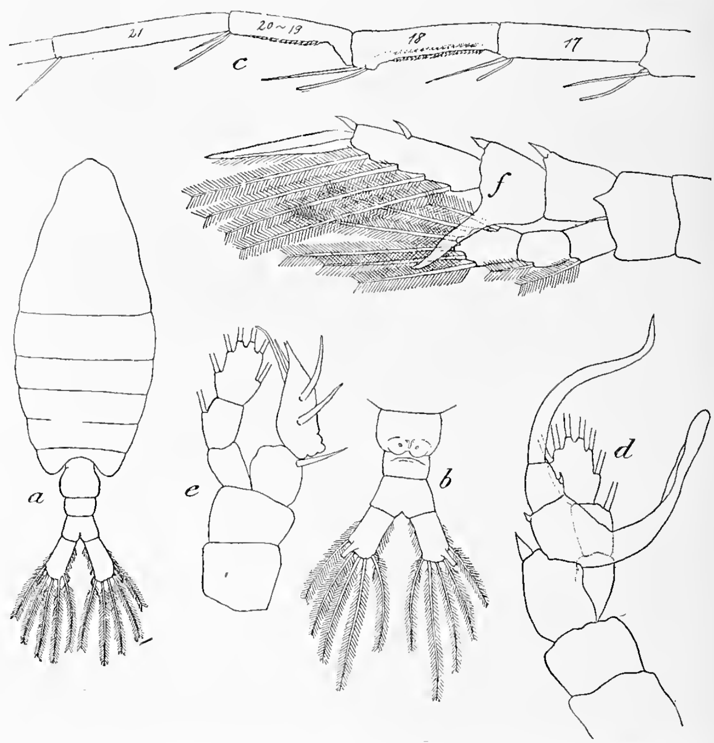
Nearly always present in considerable numbers in tow taken from Fish Commission's wharf at Woods Hole and elsewhere in vicinity.

12. Centropages bradyi new species.

Brady in his report on the Copepoda of the *Challenger* expedition (1883, p. 83, pl. XXVII) describes and figures, as *C. violaceus* Claus, a species which, as Giesbrecht has shown, can not possibly be Claus's species. From a number of specimens of both sexes, of what is undoubtedly Brady's species, taken in the Gulf Stream 70 miles south of Marthas Vineyard, July 25, 1899, it is very evident that this form must be added to the species described and enumerated by preceding authors. It differs from *C. violaceus* Claus in the following salient characters:

Female: Second joint of outer ramus of fifth foot with a stout, smooth spine. Sides of inflated genital segments without spines or knob-shaped projections. Furca symmetrical with a peculiar, short, truncated, peg-shaped projection between insertions of two outer bristles.

Male: Joint 17 of right anterior antenna with a smooth anterior border, not serrate; joints 19 and 20 fused, separated from joint 21; joint 18 with an accessory series of teeth on lower surface. Forceps of fifth pair of feet differing in many respects from same pair of feet in *C. violaceus* (see fig. 12, *d* and *e*). The peg-shaped appendage between two outer furcal bristles is not attached to a bristle, as in Brady's fig. 1, pl. XXVII. In both sexes the antennæ are very long and slender and exceed the furca by at least their 3 or 4 terminal joints.



12. *Centropages bradyi* new species; *a*, female, dorsal aspect; *b*, female, abdomen, ventral aspect; *c*, male, right anterior antennæ, joints 17–21; *d*, male, right fifth foot; *e*, male, left fifth foot; *f*, female, fifth foot.

Coloration: Rather opaque, with a large purplish spot in middle of body. Plumes of posterior antennæ and maxillæ orange-yellow toward their tips.

TEMORA Baird.

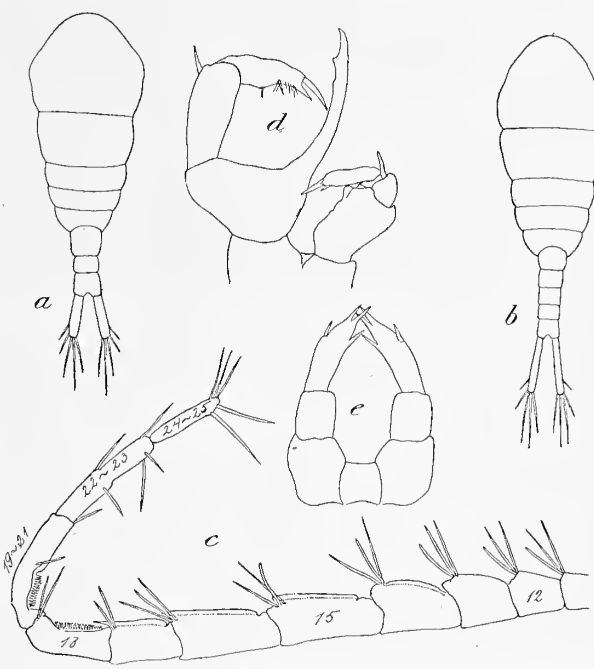
Furca long, slender, at least 7 times as long as broad. Anterior antennæ 24-jointed; the twenty-fourth and twenty-fifth joints fused, the first separated from the undivided second. First pair of feet with 3-jointed outer and 2-jointed inner ramus; in the second to fourth pairs the line of division

between the proximal joints in both rami of the female is obliterated, whereas outer ramus usually remains 3-jointed in the male. Fifth pair of feet rudimental in the female, 3-jointed on either side; in male, on the left, 4-jointed, forcipate; on the right, 3-jointed, uncinate. Grasping antenna of male on right side.

Female: Cephalothorax consisting of 5 segments; last two thoracic segments fused; rostral filaments soft. Abdomen with 3 segments; furca long, narrow, and sometimes asymmetrical. Anterior antennæ with delicate æsthetasks and short, flaccid bristles on anterior margin. Posterior antennæ similar to those of *Centropages*, but outer ramus is more slender and with a shorter end joint. Mandibular blades voluminous. The succeeding 3 pairs of appendages resembling those of *Calanus*, anterior maxilliped with long lobes. First pair of feet with 3-jointed outer ramus and 2-jointed inner ramus (first and second joints coalesced); in second to fourth pairs the articulation between the two proximal joints of both rami has disappeared; first basal joint in second to fourth and usually also in first pair with a plumose inner marginal bristle. Bristles in rami as follows: In first pair outer ramus with 1, 1, 2 outer and 1, 1, 4 inner marginal bristles; in second to fourth pairs outer marginal bristles 1, 1, 3, inner 1, 1, 5; inner ramus of first pair with 0, 1 outer, 1, 5 inner marginal bristles; second and third pairs with 0, 0, 1 outer, 1, 2, 5 inner marginal bristles; fourth pair with 0, 0, 1 outer, and 1, 2, 4 inner marginal bristles.

Male: Sexual peculiarities in structure of trunk, of right anterior antenna, and in feet, especially those of fifth pair. Last thoracic segment asymmetrical; abdomen consisting of 5 segments, the genital opening sinistral. Grasping antenna dextral, similar to that of *Centropages;* the articulation between the eighteenth and nineteenth joints; joints 19 to 21, 22 to 23, 24 to 25 fused. Outer ramus of feet sometimes 2-jointed in left foot of second pair, otherwise 3-jointed.

Length of female, 1 to 1.5 mm.; of male, 1 to 1.35 mm.



13. *Temora longicornis* O. F. Müller; *a*, female, dorsal aspect; *b*, male, dorsal aspect; *c*, male, distal portion of right anterior antenna; *d*, male, fifth pair of feet; *e*, female, fifth pair of feet.

13. Temora longicornis O. F. Müller.

Lateral corners of last thoracic segment rounded; furca symmetrical; furcal bristles short, none of them as long as furca, outermost bristle near tip of outer margin, second bristle slightly thickened at its base. Joint 17 of grasping antenna not pectinated; number of appendages on proximal joints of grasping antenna differing somewhat from those on left. First basal joint of first foot without an inner marginal bristle; second and fourth foot symmetrical, even in male; inner marginal prong on terminal joint of fifth foot of female somewhat shorter than two terminal prongs; terminal joint of left fifth foot in male irregularly rod-shaped.

A very common species in tow taken from the Fish Commission's wharf at Woods Hole. A glance at the tow collected throughout the year by Mr. Edwards shows that the species is much more abundant during winter than summer. During July and August, 1899, it was rarely seen. It is an essentially boreal form as shown by the list of localities given by Giesbrecht.

METRIDIA Bœck.

Closely related to *Pleuromma* (*q. v.*), but without lateral pigmented knob; terminal saw of outer ramus of third pair of feet of normal structure; feet of male (especially those of second pair) agreeing with those of the female. Furca 2 to 5 times as long as broad.

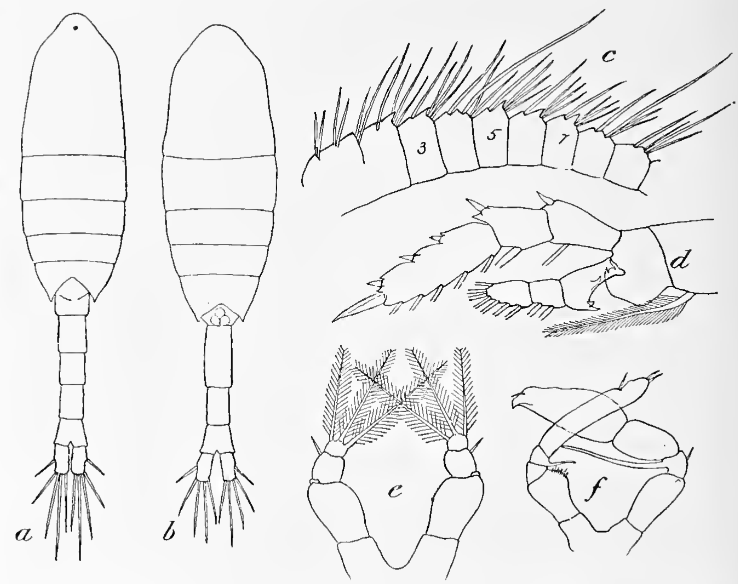
14. Metridia hibernica Brady & Robertson.

Female: Cephalothorax about $1\frac{3}{5}$ times as long as abdomen; lateral corners of fifth thoracic segment slightly pointed; genital segment somewhat shorter than fourth and fifth abdominal segments together, and fifth abdominal only three-fourths as long as fourth; furca somewhat shorter than fifth abdominal segment and twice as long as broad. Anterior antennæ scarcely reaching posterior margin of genital segment, joints 2 *a*, *b*, *c*, and 3 to 11 each with 2 æsthetasks. Terminal bristle of third joint of outer ramus of fourth foot but little more than one-fourth as long as joint. Fifth foot 3-jointed with 3 long bristles on terminal joint.

Male: Grasping antenna on right side. Fifth foot has second joint of outer ramus of left foot without, first joint of outer ramus of right foot with, a long thorn; the latter and the third joint of right outer ramus relatively shorter than in *M. longa* Lubbock.

Length of female, 2.45 to 2.85 mm.; of male, 2 mm.

This species was very common in the tow taken by the *Fish Hawk* in Plymouth Harbor in August, 1899. A single female specimen was found in tow taken at Woods Hole, December 15, 1898. Like *Temora longicornis*, *M. hibernica* is distinctively a boreal species.



14. *Metridia hibernica* Brady & Robertson; *a*, male, dorsal aspect; *b*, female, dorsal aspect; *c*, female, proximal joints of right anterior antenna; *d*, female, second foot; *e*, female, fifth pair of feet; *f*, male, fifth pair of feet.

PLEUROMMA Claus.

A dark, pigmented, chitinous knob on side of first thoracic segment. Furca at most twice as long as broad. Anterior antennæ 23-jointed; joints 1 and 2*ab* fused (2*c* separate), 7 to 9 fused, 24 and 25 separate. Rami of first to fourth pairs of feet 3-jointed; first joint of outer ramus of third pair with deep incision on the outer margin; terminal bristle of third pair short, bent over to outside; first joint of inner ramus of second pair with hooks on inner margins, in female on both sides, in male only on one side; fifth pair of feet in female rudimental, 2 to 4 jointed; in male 5-jointed on either side, without true forceps. Grasping antenna of male sinistral or dextral.

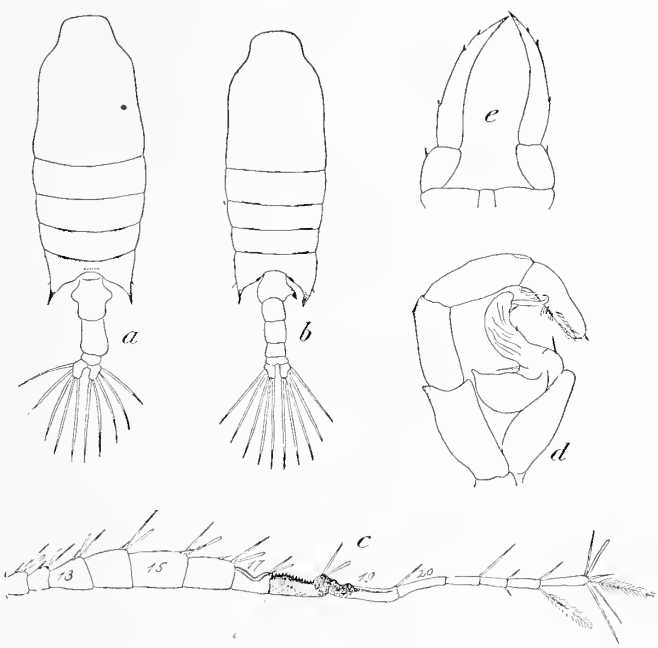
Female: Cephalothorax with 5 segments, the last two thoracic segments fused; rostral filaments plumose, inserted on a papilla; pigmented chitinous knob of first thoracic segment on left or right side. Abdomen with 3 segments, symmetrical. Anterior antennæ toothed along anterior margin of proximal joints; joints 1, 3, 7, 14, 18, 21, 24 with elongated distal bristle; æsthetasks short, filiform. Outer ramus of posterior antennæ longer than inner, 7-jointed. Mandibles and maxillæ similar to those of *Calanus* and *Centropages;* anterior maxilliped with strongly projecting fifth lobe; posterior maxilliped with elongated inner ramus. The first four pairs of feet with 3-jointed rami; first basal joint with well-developed inner bristle on all, second basal joint with inner bristle on first pair. Bristles of rami: Outer ramus with 1, 1, 2 outer bristles, 1, 1, 4 inner bristles in first, with 1, 1, 3 outer bristles, 1, 1, 5 inner bristles in second pairs; inner ramus with 0, 0, 1 outer bristles, 1, 2, 4 inner bristles on first, 0, 0, 2 outer and 0, 2, 6 inner bristles on second, 0, 0, 2 outer and 1, 2, 6 inner bristles on third, and with 0, 0, 2 outer and 1, 2, 5 inner bristles on fourth pairs.

Male: Sexual peculiarities in structure of trunk, anterior antennæ, fifth and other pairs of feet. Abdomen with 5 segments, sometimes asymmetrical, with dextral or sinistral genital orifice.

Family CANDACIDÆ.

CANDACE Dana.

Female: Fourth and fifth thoracic segments fused; head anteriorly rectangular; rostral filaments replaced by one or two small projections; lateral corner of last thoracic segment pointed. Abdomen consisting of 3 segments, often with asymmetrical genital segment. Anterior antennæ 23 or 24 jointed (twenty-fourth and twenty-fifth joints always, second and third often, fused), their proximal joints incrassated, with crenated anterior margin; bristles stiff, some elongated; æsthetasks delicate, in part rather long. In posterior antennæ the distal basal is fused with proximal joint of inner ramus to form a thick joint; rami short, outer ramus slender, with elongated second and much shortened end joint. Mandible with voluminous basal, short rami and two-pronged blades (Kaulade). Second inner marginal lobe of maxilla much elongated, whereas remaining lobes and rami remain small, and third inner marginal lobe and outer marginal lobe are wanting; some of the usually stiff bristles much elongated. Anterior maxilliped elongated, without lobes; distal bristles robust, falcate. Posterior maxilliped small and weak, its second basal joint and inner ramus abbreviated. First to fourth pair of feet with 3-jointed outer and 2-jointed relatively narrow inner rami; proximal basal joint with an inner marginal bristle on second and third and usually also on first pair; distal basal joint of first pair rarely with an inner marginal bristle. Bristles of rami, as follows: In outer rami of first pair, outer marginal bristles 1, 1, 2, inner 1, 1, 4; in the second to fourth pairs, outer marginal bristles 1, 1, 3, inner 1, 1, 5; inner rami of first pair with 0, 1 outer and 3, 5 inner marginal bristles; second to third pairs with 0, 2 outer and 3, 6 inner marginal bristles; fourth pair with 0, 2 outer, 3, 5 inner marginal bristles. Outer border of outer rami denticulate. Fifth pair of feet abortive, 3-jointed on either side.



15. *Candace pectinata* Brady; *a*, female, dorsal aspect; *b*, male, dorsal aspect; *c*, male, right anterior antenna; *d*, male, fifth pair of feet; *e*, female, fifth pair of feet.

Male: Sexual differences in structure of trunk, anterior antennæ, and fifth pair of feet. Last thoracic segment often asymmetrical; its right posterior corner characterized by peculiarities in structure, size, and coloration; abdomen with 5 segments; genital segment also often asymmetrical, with outgrowths on right side; genital orifice sinistral. Left anterior antenna usually with an increased number of æsthetasks; right antenna a grasping organ, usually with joints 17 and 18, 19 and 20, and occasionally also 8 to 10 fused. Right fifth foot 3-jointed, left 4-jointed; right foot terminating in forceps or in a bristle.

15. Candace pectinata Brady.

Genital and succeeding segment asymmetrical in female, the latter projecting backward on right side; last thoracic segment of male asymmetrical. Anterior antennæ 23-jointed, comb of eighteenth joint of grasping antenna coarsely toothed; the joints before and after the articulation stout, joint 17 rather distinctly separated from 18, and 19 from 20. Proximal hook-like bristle of second basal of anterior maxillipeds as thick and nearly as long as distal ones. Terminal joint of fifth foot of female long, claw-shaped, without inner marginal bristles; right fifth foot of male with forceps.

Coloration: Moderately transparent with a reddish tinge to cephalothorax, chitin of posterior edges of thoracic segments, lateral points of last thoracic segment, genital orifice, bristles of outer and sometimes of inner rami of feet, and the eighteenth and to some extent the nineteenth joint of the grasping antenna blackish brown.

Length of female, 1.95 to 2.4 mm.; of male, 1.7 to 2.12 mm.

A considerable number of both sexes of this handsome and widely distributed species were taken in Gulf Stream July 25 and 29, 1899.

Family PONTELLIDÆ.

LABIDOCERA Lubbock.

Fourth and fifth thoracic segments fused; head sometimes with lateral hooks; one pair of dorsal eye lenses, which are larger in male than in female; ventral eye pyriform; rostrum without lenses, its prong short, pointed; fifth thoracic segment produced on either side into a process or point, not always symmetrical; abdomen of female with two or three segments; genital segment and sometimes also furca asymmetrical; in male symmetrical. Anterior antennæ of female 23-jointed; in right one of male the thirteenth and fourteenth and the nineteenth to twenty-first joints fused. Mandibular blade with hook-like, pointed teeth. Second basal joint of maxilla about twice as long as second inner lobe; third inner lobe present. Posterior maxilliped 6-jointed (terminal joint very minute). Inner ramus of first pair of feet 2-jointed.

Female: Cephalothorax 5-jointed; rostral hooks rather strongly chitinized. Anterior antennæ 23-jointed, joints 6 and 7 and 24 and 25 fused, but there are other incompletely separated joints; some of the bristles on the proximal and distal joints plumose, æsthetasks filiform. In posterior antennæ the distal basal joint is almost completely fused with proximal joint of inner ramus; outer ramus nearly as broad as inner and as long as proximal joint of inner ramus, or somewhat longer; terminal joints of outer ramus reduced. Mandible with rather long basal and 5 to 7 teeth on its blade. Distal basal joint of maxilla with rami bent over to outside; first outer marginal lobe short, with 7 bristles, second with one plumose bristle; first inner marginal lobe relatively small, second about half as long and broad as distal basal joint which is fused with first two joints of inner ramus. Anterior maxilliped stout and provided, especially on its distal half, with robust hooked and curved bristles. Posterior maxilliped in its entire form similar to that of *Calanopia*, but its second basal joint and inner ramus are longer and the latter is only 4-jointed, first to fourth pair of feet with 3-jointed outer and 2-jointed inner rami; first basal joint with a plumose inner marginal bristle on all pairs, second to fourth pairs with short plumose outer marginal bristle; number of bristles on rami as in *Calanopia*; fifth pair of feet abortive, consisting on either side of a 2-jointed basal and two 1-jointed rami, of which only the inner is sometimes produced into a papilliform appendage.

Male: Sexual differences in the structure of the trunk (eyes), anterior antennæ, and fifth pair of feet. Dorsal eye lenses larger than in the female, contiguous in the median line; last thoracic segment symmetrical or with more strongly developed right posterior corner. Abdomen with 5 segments, symmetrical; genital opening sinistral. Left anterior antenna with longer æsthetasks, and sometimes also with other modifications, which remind one of the peculiarities of right anterior antenna; in the latter joints 6 and 7, 13 and 14, and 19 to 21 are fused, whereas the twenty-second, twenty-third, and twenty-fourth to twenty-fifth remain separate, middle joints quite strongly incrassated, and the two in front and behind articulation are provided with furrowed ridges; in some species, perhaps in all, the eighteenth can be drawn up against the seventeenth toward posterior margin of latter. Fifth pair of feet consisting on either side of four joints, of which the two distal ones of right foot constitute powerful forceps; left foot sometimes with a rudiment of an inner ramus.

16. Labidocera æstiva new species.

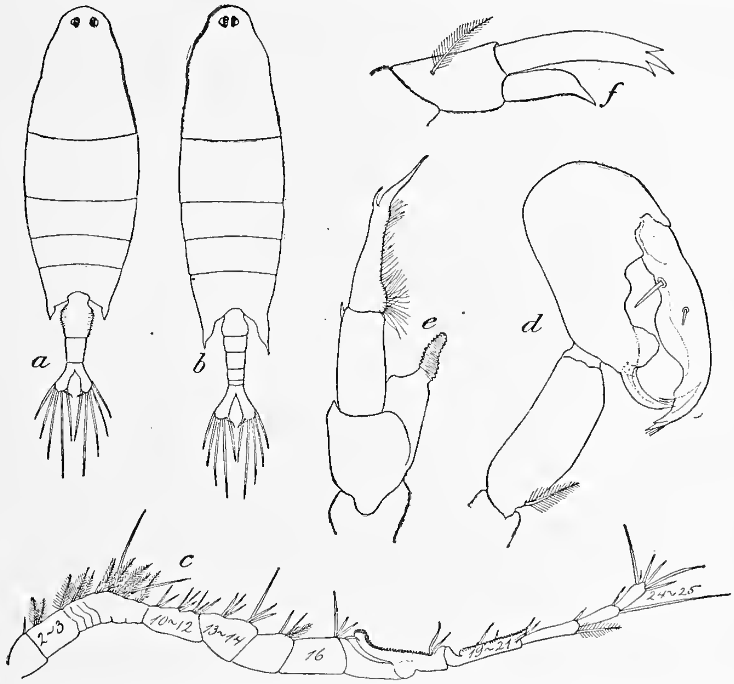
Female: Cephalothorax evenly rounded anteriorly, devoid of crista on front or hooks on front or sides of the head. Last thoracic segment symmetrical, produced on either side into a sharp point. Abdomen consisting of 2 segments, first much longer than second, perfectly symmetrical and projecting over second, covered with minute hairs on sides. Genital orifice in middle of its ventral surface. Second abdominal segment about twice as long as broad. Furca symmetrical, its limbs at least $2\frac{1}{2}$ times as long as broad. Anterior antennæ reaching to hind end of genital segment. Fifth pair of feet symmetrical; outer ramus terminating in 3 teeth, the middle nearly twice the length of other two; inner ramus more than half the length of outer, articulating with basal, and ending in a single strong, pointed tooth.

Male: Differs from the female in following characters: Eyes with larger lenses, nearly con-

tiguous. Last thoracic segment produced into longer points, the one on right side being distinctly longer than that on left. Abdomen consisting of 5 segments; anal segment very short, first segment without hairs on its sides. Anterior antennæ reaching to base of furca; joints 16 and 17 of about equal length, the latter provided with a recurved spine on its anterior basal surface; teeth on eighteenth joint uniform, somewhat larger and more hook-like than teeth on fused nineteenth and twentieth, which are fully one third longer than twenty-second joint and terminate in a distinct point distally. Bristles on joints 23 and 24 to 25, not plumose. For structure of fifth pair of feet, see fig. 16, *d* and *e*.

Coloration, transparent, without pigment. Length, 1.75 to 2 mm.

This species appears to be sufficiently distinct from any of the described 13 species of *Labidocera*, nor can it be referred to any of the insufficiently described and figured species of *Pontella* in Dana's monograph. Of known forms it approaches *L. nerii* Kröyer, but may be distinguished by the sym-



16. *Labidocera æstiva* new species; *a*, female, dorsal aspect; *b*, male, dorsal aspect; *c*, male, right anterior antenna; *d*, male, right fifth foot; *e*, male, left fifth foot; *f*, female, fifth foot.

metrical genital segment of female and the acute tooth terminating inner ramus of fifth foot. The male may be distinguished from the male *nerii* by the asymmetry of the last thoracic segment and many differences in configuration of fifth pair of feet. (Conf. Giesbrecht's fig. 45, pl. 24.)

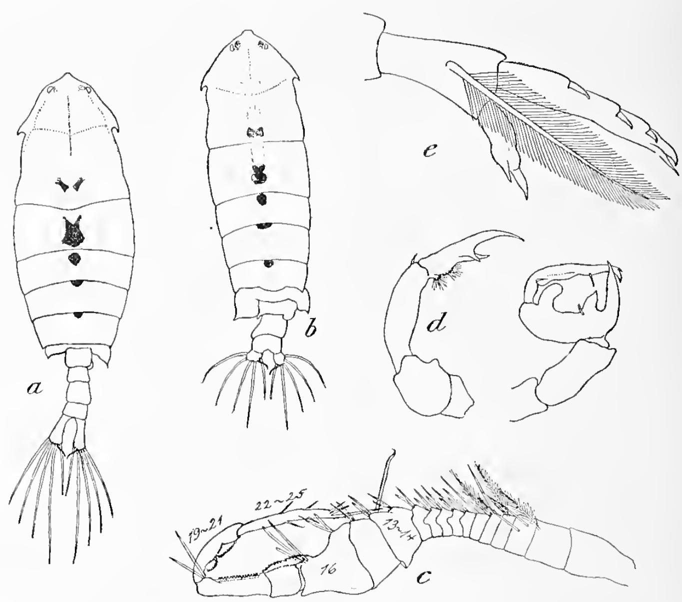
L. æstiva was very common in the tow taken from the Fish Commission wharf at Woods Hole during July and early August, 1899.

PONTELLA Dana.

Fourth and fifth thoracic segments separated; head with lateral hooks; one pair of dorsal eye-lenses and a rostral lens in front of ventral eye, the latter sometimes thicker in male than in female; rostral prong stout; last thoracic segment with pointed lateral corners, not always symmetrical; abdomen of female with 2 or 3 segments, asymmetrical; that of male (apart from one-sided genital orifice) symmetrical. Anterior antennæ of female 24-jointed; right one of male with fused thirteenth and fourteenth, nineteenth to twenty-first, twenty-second to twenty-fifth joints. Mandibular blade with hooked, pointed teeth; second basal joint of maxilla about $1\frac{1}{2}$ times as long as second internal lobe; third internal lobe present. Posterior maxilliped 7-jointed; inner ramus of first pair of feet 3-jointed.

Female: Cephalothorax 6-jointed; rostral prongs stout, with a common broad base, the cuticle of which is converted into a lenticular thickening; last thoracic segment prolonged on either side into 1 or 2 points, sometimes asymmetrical. Anterior antennæ short, 24-jointed (twenty-fourth and twenty-fifth joints fused), with indistinct boundaries between several of the joints; appendages similar to those of *Labidocera*. In posterior antennæ the distal basal joint is only incompletely separated from proximal joint of inner ramus; outer ramus narrower than inner and about as long as proximal joint of latter. This appendage as well as mandible (blade with 7 teeth), the maxilla (distal basal joint $1\frac{1}{2}$ times as long as second inner marginal lobe), and also the anterior maxilliped similar to that of *Labidocera*. Posterior maxilliped with 7 joints (inner ramus 5-jointed); first to fourth pair of feet with 3-jointed outer ramus; inner ramus of first pair 3-jointed, of second to fourth pairs 2-jointed; first basal joint with plumose inner marginal bristle on all pairs, second basal joint with plumose outer marginal bristle on fourth, and sometimes with an inner marginal bristle on first pair. Number of bristles of rami as in *Calanopia;* fifth pair of feet as in *Labidocera*.

Male: Sexual differences in structure of trunk, of anterior antennæ, and of fifth pair of feet. Dorsal eye-lenses as in female; rostral lens often much thicker than in that sex; last thoracic segment departing from that of the female, usually symmetrical. Abdomen with 5 segments; genital opening sinistral, otherwise symmetrical. In left anterior antennæ the middle joints are shortened, æsthetasks larger; right anterior antenna a powerful grasping organ with sometimes much dilated middle joints; joints 13 and 14, 19 to 21, 22 to 25 are fused; also in incrassated proximal region there are some less complete fusions of joints; anterior border of seventeenth to twentieth joints with ridges and projections, which are usually striated. Fifth pair of feet like that of *Labidocera*, but without a rudiment of an inner ramus in left foot.



17. *Pontella meadii* new species; *a*, male, dorsal aspect; *b*, female, dorsal aspect; *c*, male, right anterior antenna; *d*, male, fifth pair of feet; *e*, female, fifth foot.

17. Pontella meadii new species.

This species closely resembles *P. lobiancoi* Giesbrecht, but may be readily distinguished from this and other species by peculiarities in structure of last thoracic segment, abdomen, fifth pair of feet in both sexes, and by grasping antenna of male. In the male there is no projection on anterior surface of eighteenth joint of grasping antenna, and first joint of outer ramus on right fifth foot is provided with two flattened lobes separated by a diastema; terminal joint of left fifth foot end in three claws, of which one is more than twice the length of the others. In the female the inner ramus of fifth pair of feet is half the length of outer, whereas in *lobiancoi* it is much shorter. In both sexes the last thoracic segment is asymmetrical. Abdomen of female with three segments, of which the first and second are asymmetrical, the first having a projection on its right posterior, the second on its left posterior corner. Furca nearly symmetrical.

Coloration: Dark bluish-green, especially on head, abdomen, and along edges of cephalothorax. More dorsal portions of cephalothorax glistening silvery white, more or less suffused with green, along sides with some reddish pigment, especially in young specimens. In middorsal line is a series of deep-black blotches, one to each segment, blotch on posterior portion of cephalic segment sometimes divided. Some black pigment along sides of posterior thoracic segments. Chitin of ventral surface and appendages pale green.

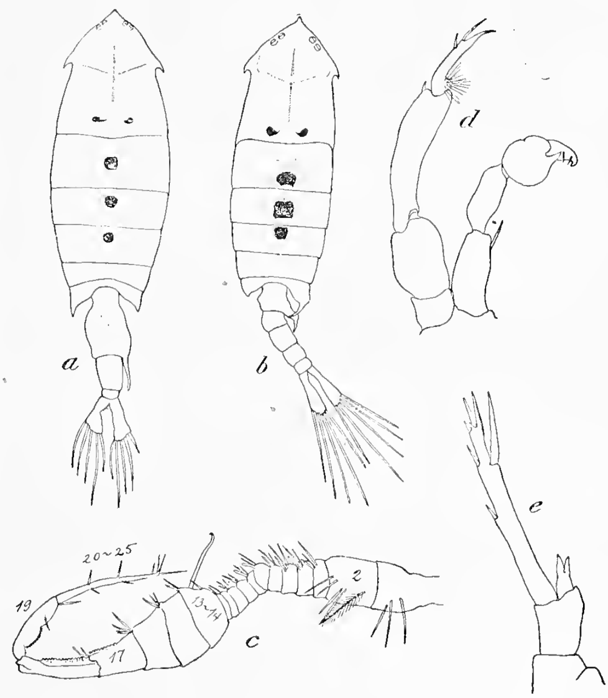
A few males and females of this handsome species were taken only on two occasions, July 17 and July 26, 1899, at 8 a. m., from the Fish Commission wharf at Woods Hole. The night before each of these days had been very stormy, with wind from southeast.

ANOMALOCERA Templeton.

Fourth and fifth thoracic segments separated; head with lateral hooks; 2 pairs of dorsal eye-lenses; ventral eye in male more strongly protruding than in female; rostrum without lenses; rostral prong powerful; fifth thoracic segment pointed on either side, asymmetrical in male. Abdomen of female with 3 segments, in female and male asymmetrical. Anterior antennæ of female 20-jointed; in right one of male joints 13 and 14, 19 to 21, 22 to 25 are fused. Mandibular blade with hook-like, pointed teeth. Second basal joint of maxilla as large as second inner lobe; third inner lobe present. Posterior maxilliped 7-jointed, inner ramus of first pair of feet 3-jointed.

Female: Cephalothorax 6-jointed; the last thoracic segment on each side extending out into a pointed projection. Abdomen with 3 segments, symmetrical. Anterior antennæ short, 20-jointed; joints 6 to 8, 9 to 11, 24 and 25 fused; appendages similar to those of *Pontella.* Outer ramus of posterior antennæ short and slender, about one-third as thick as proximal joint of inner ramus, which is fused with second basal joint. Basal joint of mandibles thicker, second inner marginal lobe of maxilla larger than in *Pontella* (somewhat longer than second basal joint, which is fused with two joints of inner ramus); the succeeding appendages similar to those of *Pontella,* but outer ramus of fifth pair of feet is 2-jointed.

Male: Sexual differences in structure of trunk, anterior antennæ, and fifth pair of feet. Ventral eye pyriform, more strongly protruding; last thoracic segment asymmetrical, on right side with a curved hook. Abdomen with 5 segments; genital opening sinistral; the anterior segments asymmetrical, first with an outgrowth on right side. Slight differences in left anterior antenna; right similar to that of *Pontella,* and same is true of fifth pair of feet, the forceps of which, however, is less powerfully developed.



18. *Anomalocera pattersonii* Templeton; *a*, female, dorsal aspect; *b*, male, dorsal aspect; *c*, male, right anterior antenna; *d*, male, fifth pair of feet; *e*, female, fifth foot.

18. Anomalocera pattersonii Templeton.

The strongly marked character of the only species of the genus *Anomalocera* may be gleaned in great part from the above figure. In its coloration it is rather opaque dark-blue or blue-green, occasionally ferruginous red. There is a series of median dorsal black blotches of very constant occurrence, with much more variable irregularly ramifying dark-blue markings on sides of thoracic segments. Gut usually bright green. Eggs white or reddish.

Length of female, 3.5 to 4.1 mm; male, 3.2 to 3 mm.

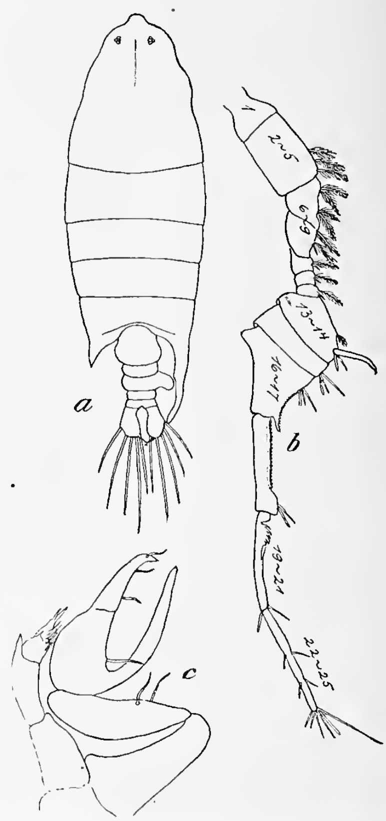
At Woods Hole this species is taken, so far as I have observed, only after stormy weather with prevailing southwest winds, either alone or in company with *Pontella meadii.* It was far more abundant in the tow collected by the *Grampus* in the Gulf Stream, about 70 miles south of Marthas Vineyard.

MONOPS Lubbock.

Fourth and fifth thoracic segments fused; head without lateral hooks; no dorsal or rostral eye-lenses; ventral eye rather flatly convex to club-shaped; rostral filaments delicate, long and flaccid; fifth thoracic segment with pointed lateral corners, usually asymmetrical in male; abdomen of female with 1 or 2 joints, asymmetrical in both male and female. Anterior antennæ of female 16-jointed, in the right antenna of male joints 13 and 14, 16 and 17, 19 to 21, and 22 to 25 fused. Mandibular blade with blunt teeth. Second basal joint of maxilla scarcely half as long as second internal lobe; third internal lobe present. Posterior maxilliped 5-jointed. Inner ramus of first pair of feet 3-jointed.

Female: Cephalothorax 5-jointed. Anterior antenna short, 16-jointed, joints 2 to 5, 6 to 8, 9 to 11, 13 and 14, and 24 and 25 fused; appendages similar to those of *Pontella*, though reduced in number and length. In posterior antennæ the distal basal joint is fused with proximal joint of inner ramus; outer ramus short and slender. Mandibular blade scarcely dilated toward tip, usually with short, blunt teeth. In maxilla the second inner marginal lobe is more than twice as long as second basal joint, which is fused with the two joints of inner ramus. Distal uncinate bristles of anterior maxillipeds long in comparison with proximal ones, sparsely provided with prickly plumes. Proximal basal joint of posterior maxillipeds broad, lobular, followed by only 4 further joints. Feet similar to those of *Pontella*.

Male: Sexual differences in structure of trunk, anterior antennæ, and fifth pair of feet. Anterior portion of cephalothorax asymmetrical, and usually the right projection of last thoracic segment is longer than left and of a peculiar form. Abdomen with 5 segments; genital opening sinistral; third segment with an outgrowth on right side. Left anterior antenna differing from that of female, especially in separation of thirteenth and fourteenth joints; proximal joints of right anterior antenna incrassated, middle joints dilated, disciform. Besides joints 2 to 5, 6 to 9, 10 to 12, 13 to 14, 19 to 21, and 22 to 25, joints 16 and 17 are also fused. Fifth pair of feet on the whole similar to that of *Pontella*.



19. *Monops regalis* Dana; male; *a*, dorsal aspect; *b*, right anterior antenna; *c*, fifth pair of feet.

19. Monops regalis Dana.

Last thoracic segment pointed on either side, in the male prolonged on right side into a powerful slightly curved hook. Abdomen of female with 2 segments, asymmetrical with outgrowths. Furca short. In male the proximal hook in forceps of right fifth foot is somewhat longer than distal hook.

Coloration: Dark blue-green, and similar to that of *Pontella* and *Anomalocera*.

Length of female, 4 to 4.4 mm; male, 3.4 to 3.5 mm.

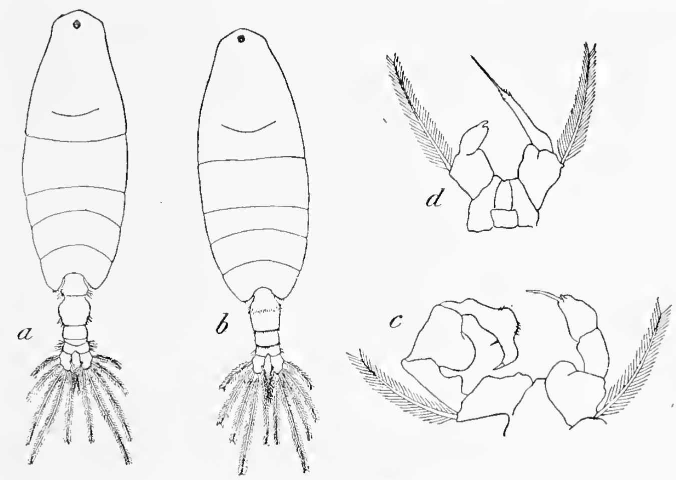
A single male specimen of this species was taken in Gulf Stream tows, 70 miles south of Marthas Vineyard, July 25, 1899.

ACARTIA Dana.

Fifth thoracic segment and abdomen of male symmetrical; the latter with abbreviated anal segment. Anterior antennæ of female 17-jointed, throughout of nearly uniform thickness, with knob-like projections at insertions of the long, usually plumose but sometimes spinose bristles; grasping antenna of male with but slightly incrassated middle joints. Outer ramus of posterior antennæ much shorter than inner ramus; second joint of inner ramus elongated, first joint with 9 bristles on its inner border. Mandible with rather elongate second basal joint; rami incompletely jointed; outer ramus articulating about on middle of margin of second basal. First outer lobe of maxilla with long bristles; outer ramus rudimental, represented by 2 bristles. Proximal lobes of anterior maxillipeds

well-developed, with long bristles. Posterior maxilliped 4-jointed. Inner ramus of first pair of feet 2-jointed; fifth pair of feet of female without inner ramus, with a long outer bristle on second basal joint.

Female: Cephalothorax with 5 segments; the two last thoracic segments fused; the last sometimes terminating in lateral joints. Rostral filaments delicate or wanting. Abdomen with 3 segments, symmetrical. Anterior antennæ 17-jointed; joints 2 to 4, 5 and 6, 7 and 8, 9 and 10, 12 and 13, 24 and 25 fused; æsthetasks delicate, filamentous. Posterior antennæ very slender, their distal basal joint fused with proximal joint of inner ramus; inner ramus with much elongated terminal joint; the very short outer ramus with relatively long proximal (first and second joints fused) and very short distal joints. Mandible with feeble, 7-toothed blade. Maxilla with abortive rami, represented only by long bristles, but with well-developed lobes. Anterior maxilliped with long curved bristles even on proximal lobes. Posterior maxilliped similar to that of *Parapontella*, but without outer marginal bristles and with three inner marginal bristles on third joint. First to fourth pair of feet with 3-jointed outer and 2-jointed inner rami; first basal joint without a bristle, second basal joint with a rather long outer marginal bristle on fourth pair; bristles of rami as follows: Outer ramus of first pair with 1, 1, 2 outer and 1, 1, 4 inner marginal bristles; second to fourth pairs with 0, 0, 0 outer and 1, 1, 5 inner marginal bristles; inner ramus of first pair with 0, 1 outer and 1, 5 inner marginal bristles; second and third pairs with 0, 1 outer and 2, 6 inner marginal bristles, fourth pair with 0, 1 outer and 3, 5 inner marginal bristles. The much reduced fifth pair of feet consists on either side of 2 or 3 joints; end joint a thick, stylet-shaped bristle, and on outer margin of second basal is a delicate plumose bristle.



20. *Acartia tonsa* Dana; *a*, female, dorsal aspect; *b*, male, dorsal aspect; *c*, male, fifth pair of feet; *d*, female, fifth pair of feet.

Male: Sexual differences in structure of trunk, anterior antennæ, and fifth pair of feet. Peculiarities in articulation of thoracic segments and sometimes in form. Abdomen with 5 segments; genital orifice sinistral; fourth segment and furca abbreviated. In both anterior antennæ the proximal joints are incrassated, and the ninth is separated from tenth, the twelfth from thirteenth joint; spines wanting; right anterior antenna transformed into a grasping organ, and joints 19 to 21, and 22 to 25 are fused. Fifth pair of feet consisting of a common median piece, a right 4-jointed, and a left 3-jointed uniramous foot; especially the right is claw-shaped, and forms an incomplete forceps, with a process on penultimate joint.

20. Acartia tonsa Dana.

Rostral filaments present; last thoracic segment rounded on sides. Abdomen relatively short, without thorns; anal segment hairy on either side; in male with fine points on second segment. Anterior antennæ of female not reaching posterior border of genital segment. For fifth pair of feet, see fig. 20, *c* and *d*.

Colorless and translucent.

Length of female, 1.3 to 1.5 mm.; of male, 1.05 mm.

This species was found to be one of the commonest copepods in tow taken from wharf of Fish Commission at Woods Hole during July and August, 1899. It appeared abundantly also in tow from Plymouth Harbor, but was very scarce in Gulf Stream 70 miles south of Marthas Vineyard. Hitherto the species has been taken only at Port Jackson, Australia (Dana), and west of South America, between Valparaiso and Callao (Giesbrecht). *Acartia clausii* Giesbrecht, which one would expect to find in our waters, could not be recognized in the samples of the tow.

CORYNURA Brady.

Fifth thoracic segment and abdomen of male symmetrical. Anterior antennæ of female 17-jointed; long bristles with lamelliform margin. Posterior antennæ with rami of nearly equal length; terminal joints of outer ramus abortive, scarcely distinguishable. Mandibles with elongated second basal joint, with end of which the rami articulate. Maxilla consisting only of first basal, with the very bristly first and second inner lobes. Proximal lobes of anterior maxillipeds minute. Posterior maxilliped 3-jointed. Inner ramus of first pair of feet 2-jointed. Fifth pair of feet of female without inner ramus, sometimes asymmetrical.

Female: Cephalothorax with 5 to 6 segments, according as last two thoracic segments are fused or separate; a large median eye, without lens; rostrum wanting, in front of upper lip a horseshoe-shaped fringed lamella. Abdomen with 2 to 3 segments, asymmetrical, sometimes twisted about longitudinal axis. Anterior antennæ resembling those of *Acartia*, 17-jointed, with joints 1 to 7, 9 and 10, 24 and 25 fused. Posterior antennæ resembling those of *Parapontella*, but outer ramus with completely abortive distal joints. Mandibular blade usually rather narrow, with 5 teeth; outer ramus scarcely jointed. Maxillipeds similar to those of *Parapontella*, but proximal lobes of anterior pairs are more decidedly reduced and inner ramus of posterior pair shorter and 1-jointed. First to fourth pair of feet with 3-jointed outer and 2-jointed inner rami; first basal joint with an inner marginal bristle on all four pairs; second basal joint without a bristle on first, with a plumose outer marginal bristle on the fourth pair; bristles of rami as follows: Outer ramus of first pair with 0, 0, 1 (2) outer and 1, 1, 4 inner marginal bristles; second to fourth pairs with 1, 1, 3 outer and 1, 1, 5 inner marginal bristles; inner ramus of first pair with 0, 1 outer and 3, 5 inner marginal bristles, of second to fourth pairs with 0, 1 outer and 3, 6 (5) inner marginal bristles. Fifth pair strongly abortive, consisting of a common median piece and a couple of 2-jointed, not always symmetrical, feet.

Male (known only in few species): Sexual differences in structure of abdomen, right anterior antenna, and fifth pair of feet. Abdomen with 5 segments; genital orifice sinistral. In right anterior antenna sixth and seventh joints are separate from fused first to fifth, and the ninth is separated from tenth; the middle joints are more strongly dilated than in *Acartia*, and, as in that genus, the nineteenth to twenty-first and the twenty-second to twenty-fifth joints are fused. Fifth pair of feet resembles that of *Acartia*, but consists (besides middle piece) of 3 joints on either side, the left being the longer.

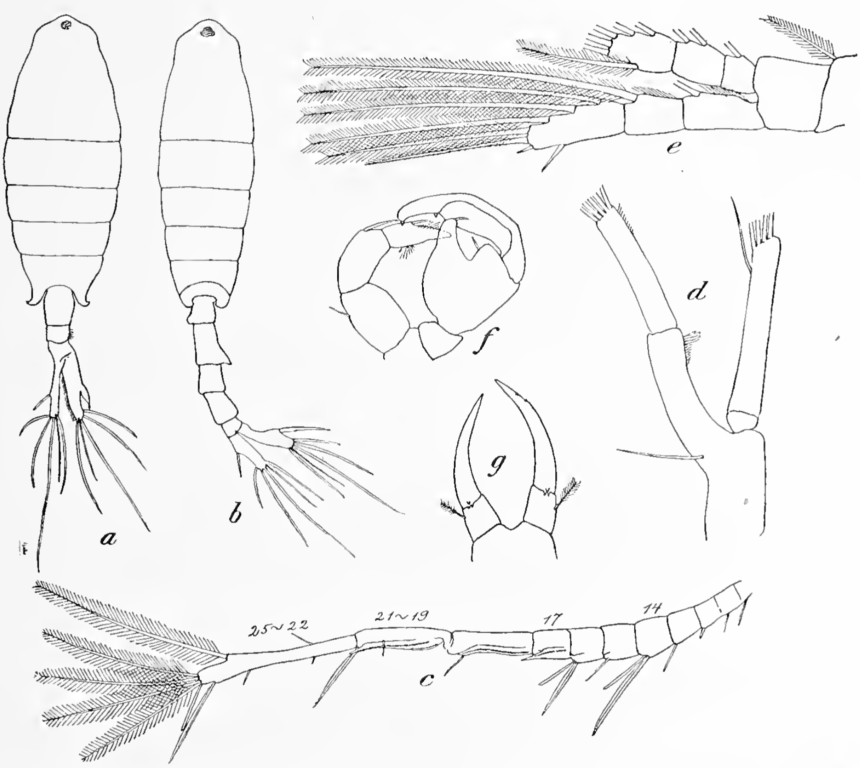
21. Corynura bumpusii new species.

Male: Body long and slender; separation between fourth and fifth thoracic segments not very pronounced, latter symmetrical, with rounded posterior corners. Abdomen consisting of 5 segments, its tip turned to right side and slightly twisted about longitudinal axis; first segment somewhat asymmetrical, with a rounded projection on left posterior corner; second with a similar but much more prominent and pointed outgrowth on right side; third and fourth segments of nearly equal length; fifth not half as long as fourth. Furca asymmetrical, its right limb distinctly longer than left, conspicuously constricted near base; inner edges of limbs fringed with delicate hairs; outermost bristle on the right side enlarged, blade-shaped, with a short, conical, dorsal, tooth-like projection a short distance beyond its base; innermost bristle slender, nearly as long as first bristle. Relative lengths of bristles $4<1<3<2$.

Eye large, without dorsal lenses. Rostrum absent, front of head evenly rounded in profile; mouth surrounded in front by a horseshoe-shaped, fringed lamella. Anterior antennæ reaching only to posterior edge of third abdominal segment; right anterior antenna not much widened in middle (joints 13 to 17), poorly furnished with bristles; joints 17, 18, 19 to 21 with delicate pectination; joints 22 to 25 fused, and bearing at tip 5 long plumose bristles. The long bristles on joints 14, 16, 21, and 24 provided along one edge with a very delicate, transparent lamina, often slightly sinuous in outline (effect of formalin?). Posterior antennæ with long, slender rami; first joint of inner ramus fused with second basal joint and bearing on its distal margin a short dense series of graduated spines; second joint with a few hairs in corresponding position; first joint of outer ramus very short; second joint reaching to middle of slender second joint of inner ramus; outer ramus terminates in 4, the inner in 6 long plumose bristles.

Mandibular blade with 5 teeth gradually decreasing in length from first, which is separated from second by a considerable diastema; second basal joint slender, fully 4 times as long as wide, rami inserted at same level on its tip, outer ramus but little longer than inner, the former with 5, the latter

with 4 plumose bristles, some of them twice the length of appendages; first joint of outer ramus scarcely one-third as long as second, first joint of inner ramus fully twice as long as second joint. Maxilla very much like that of *Corynura forcipata* Giesbrecht, rami absent, rounded inner lobe provided with 11 hook-shaped, coarsely plumose bristles, external lobe slender, terminating in 3 strong, hook-shaped bristles, which are edged with short points. Anterior and posterior maxillipeds closely resembling the corresponding appendages of *C. forcipata*, but the points on the 7 long hook-shaped bristles of former pair of appendages more strongly developed, and there are only 3, instead of 4, prickly bristles on first basal joint of latter pair; first pair of feet with 3-jointed inner rami; inner rami of second to fourth pairs 2-jointed. In other respects structure of feet closely resembles that of congeneric species. Thus, the first foot is very much like that of *C. denticulata*, Giesbrecht, except for the 3-jointed inner ramus; fifth pair of feet asymmetrical, each 3-jointed; right foot longer and more voluminous than left, its second and third joints forming massive forceps.



21. *Corynura bumpusii* new species; *a*, female, dorsal view; *b*, male, dorsal view; *c*, male, distal portion of right anterior antenna; *d*, male, posterior antenna; *e*, male, first foot; *f*, male, fifth pair of feet; *g*, female, fifth pair of feet.

Female: Fourth and fifth thoracic segments fused, the latter ending on either side in a curved, ventrally and laterally directed process. Abdomen with 3 segments, genital segment large, somewhat swollen, as long as the 2 succeeding subequal segments together. Second segment with a cluster of bristly hairs on right side. Anal segment asymmetrical, fused with furca. Two limbs of furca of equal length, but the right is more than twice as broad as left, fringed with hairs along its inner border and bearing in place of outermost bristle a rigid, flattened, and pointed spine. This and the very slender innermost furcal bristles are not plumose; plumes on the apical fourth of long second furcal bristle, coarse and sparse. Anterior antennæ reaching to base of furca, resembling those of *C. forcipata*, with several of median and basal joints fused together; large bristles with lamelliform margins; bristles on two terminal joints very long and coarsely plumose. Both sexes rather opaque and without pigment except along mid-ventral line, where there are segmental accumulations of black coloring matter in the male.

Length of male, 1.8 to 2 mm.; of female, 2.25 mm.

The males of this species, which I take pleasure in dedicating to my friend, Prof. H. C. Bumpus, appeared in considerable numbers in tow taken off Fish Commission wharf July 10 and 11, 1899, and again in Vineyard Sound, near Gay Head, Marthas Vineyard, on the latter day. The single female specimen from which the above description was drawn was found in some tow collected by Mr. Vinal N. Edwards at Woods Hole, December 15, 1898.

C. bumpusii is remarkable in two respects. First, it differs from all the known species of *Corynura* in having 3 instead of 2 jointed inner rami on first pair of feet. Giesbrecht's diagnosis of the genus should be widened to receive this species. Second, the occurrence of a *Corynura* in the Atlantic has not before been recorded. The five species hitherto described are all from the east coast of Asia, thus: *C. forcipata* Giesbr. is from Amoy; *C. denticulata* Giesbr. and *C. recticauda* Giesbr. are from Assab; *C. gracilis* Brady and *C. barbata* Brady from the Philippines.

Suborder PODOPLEA.

Family CYCLOPIDÆ.

OITHONA Baird.

Female: Cephalothorax and abdomen with 5 segments (first and second abdominal segments fused); front usually terminating in a pointed, beak-like process; genital opening lateral. Anterior antennæ in part indistinctly jointed, with long bristles, without æsthetasks. Posterior antennæ 2-jointed (first basal joint fused with second, first joint of inner ramus with second), with indistinct bipartition of second joint; outer ramus wanting. Mandible elongated, with small, 1-jointed inner, and 4-jointed outer ramus and denticulate blade. Maxilla with well-armed masticatory process (first inner lobe) and with uncinate bristles even on other portions of inner margin; rami 1-jointed, inner ramus small, first outer lobe rudimental. Maxillipeds slender, with powerful, prickly bristles, the posterior with 2-jointed inner ramus. Feet with 3-jointed rami; fifth foot very rudimental, on either side reduced to 2 bristles.

Male: Front obtuse. First and second abdominal segments separated; furcal bristles abbreviated, anterior antennæ grasping organs each geniculating at two points, with a terminal æsthetask; feet with somewhat aberrant bristles.

22. Oithona plumifera Baird.

Female: Front ending in a pointed beak, which is bent ventrally somewhat, but is still visible from dorsal aspect; furca shorter than anal segment, nearly 3 times as long as broad; its outermost bristle about 3 times as long as furca. Anterior antennæ reaching to posterior border of fourth abdominal segment. Second basal joint of mandibles with 2 hook-like bristles. Inner ramus of maxillæ with a few minute bristles. Outer ramus of first pair of feet with 1, 1, 2, the third with 1, 0, 2, the fourth with 0, 0, 2 outer marginal bristles; proximal outer bristle of third outer ramus of third and fourth pairs reduced.

Male: Genital segment broad. Proximal joint of distal portion of anterior antennæ with a semi-circular projection on inner margin. Third joint of outer ramus of first and fourth pairs of feet with 2, the second and third with 3 outer bristles.

Coloration: Very transparent, with ferruginous pigment very variously distributed through cephalothorax, especially in oral region, sometimes forming symmetrical spots in thorax, more rarely in abdomen, often in long bristles of anterior antennæ, furca, and feet; other individuals are quite colorless except for the ruby-red eye.

Length of female, .01 to 1.5 mm; of male, .075 mm.

Three female specimens taken in the Gulf Stream, 70 miles south of Marthas Vineyard, July 25, 1899. These specimens were colorless.

23. Oithona similis Claus.

Female: Front ending in a hooked, pointed beak which is bent ventrally at a right angle and hence not visible from dorsal aspect; genital orifices situated further posteriorly than in other species of the genus; furca shorter than anal segment, nearly 2½ times as long as broad, its outermost bristle about as long as furca. Anterior antennæ scarcely reaching to genital orifices. Second basal

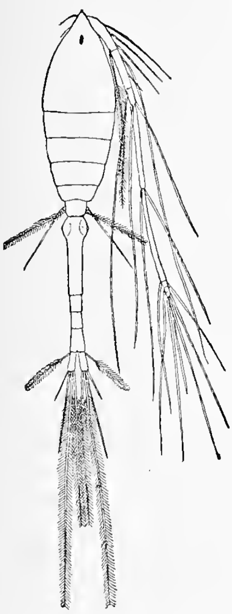
joint of mandibles with 2 hook-shaped bristles. Inner ramus of maxillæ with a minute bristle. Outer ramus of first pair of feet with 1, 1, 2, of second and third with 1, 0, 1, of fourth with 0, 0, 0, outer marginal bristles.

Male: Genital segment smaller than in *O. plumifera*. Proximal joint of distal portion of anterior antennæ with a semicircular process on inner margin. Third joint of outer ramus of first to fourth pairs of feet with 2 outer marginal bristles.

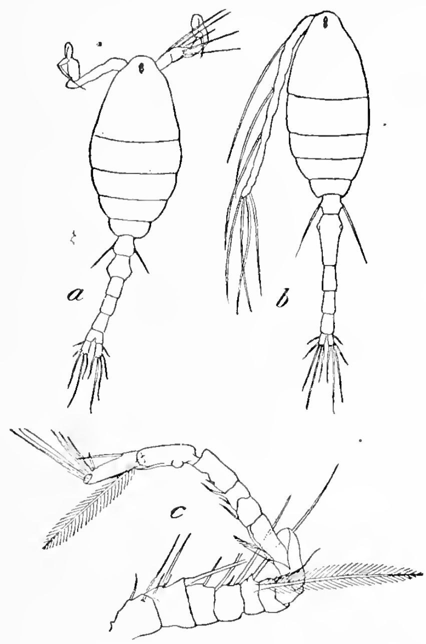
Coloration: Similar to *O. plumifera*, but usually less colored.

Length of female, 0.73 to 0.8 mm.; of male, 0.59 to 0.61 mm.

This species occurred occasionally in small numbers in the tow taken from the Fish Commission wharf at Woods Hole during July, 1899. All the specimens were colorless.



22. *Oithona plumifera* Baird; female.



23. *Oithona similis* Claus; *a*, male, dorsal aspect; *b*, female, dorsal aspect; *c*, male, anterior antenna (dorsal surface); after Giesbrecht.

Family HARPACTICIDÆ.

SETELLA Dana.

Female: Trunk long and slender, laterally compressed. Cephalothorax with 4 segments (head fused with first thoracic), abdomen with 5 segments (first and second segments fused); rostrum movable; furca rod-shaped, with very long bristles. Anterior antennæ 8-jointed, with æsthetasks on fourth and eighth joints. Posterior antennæ short, 2-jointed (basal fused with first joint of inner ramus), without a trace of an outer ramus. Succeeding 3 pairs of limbs minute; mandible 1-jointed, without rami, with denticulate blade; maxilla also 1-jointed and without rami; anterior maxilliped with 2 lobes and short terminal hooks. Posterior maxilliped longer and more powerful, 2-jointed, with terminal hooks. Feet with very long and slender rami; inner ramus of first pair 2-jointed; remaining rami 3-jointed; fifth pair of feet rudimental, elongate leaf-shaped.

Male: With separate first and second abdominal segments; grasping antennæ 8-jointed, with articulation between fifth and sixth joint; fifth pair of feet similar to those of the female, but smaller, with weaker bristles; sexual differences also in first and especially in second pair of feet.

24. Setella gracilis Dana.

This single strongly marked species should include, according to Geisbrecht, besides *S. gracilis* Dana, some four other forms regarded by Dana as distiuct species, also *Miracia gracilis* Dana, *Setella tenuis* Lubbock, and *S. messinensis* Claus. In color the chitin of body aud of proximal portions of limbs is transparent violet; gut ferruginous red surrounded by oil drops which are colorless or yellowish and usually darker in the oral region; eye ruby-red.

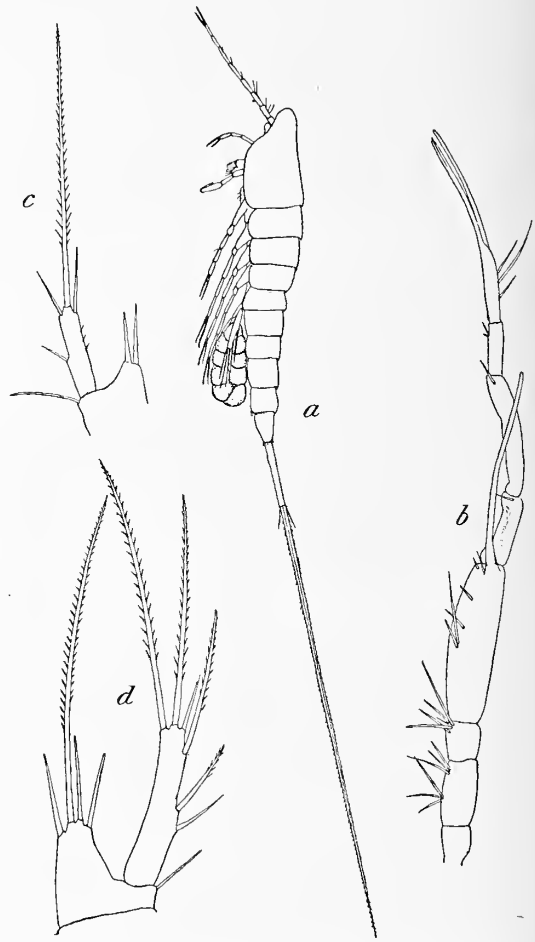
Length of female, 1.4 to 1.5 mm.; of male, 1.16 to 1.3 mm.

Several specimens, many ovigerous females and a few males, were taken in Gulf Stream, 70 miles south of Marthas Vineyard, July 25, 1899.

MIRACIA Dana.

Male: Cephalothorax with 4 segments (head fused with first thoracic), abdomen with 6 segments; head and first thoracic segment laterally compressed, with two large chitinous lenses on front; furca rather long. Anterior antennæ grasping organs, 9-jointed, articulation between the sixth and seventh joints; bristles short, one æsthetask on fourth joint. Posterior antennæ 3-jointed (second basal joint fused with first joint of inner ramus), with very small, 1-jointed outer ramus. Mandible (like succeeding limbs) small, with rudimental rami and denticulate blade. Posterior maxilliped elongated, rod-shaped, 2-jointed, with short terminal hooks. Feet elongated; outer ramus 3-jointed; inner ramus of first and second pairs 2-jointed, of third and fourth pairs 3-jointed; inner ramus of second pair of peculiar structure; fifth pair of feet rudimental, leaf-shaped.

Female: Differs from male (according to Brady), in fusion of first and second abdominal segments, in structure of 8-jointed anterior antennæ, of 3-jointed, normally constructed inner ramus of second pair of feet, and in fifth pair of feet.



24. *Setella gracilis* Dana; *a*, female, from the left side; *b*, male, anterior antenna; *c*, male, fifth foot; *d*, female, fifth foot.

25. Miracia efferata Dana.

Some 30 specimens of both sexes of this, the only species of the genus, were taken in the Gulf Stream about 60 miles south of Marthas Vineyard, July 28, 1899, late in the afternoon. The female is dark greenish-blue, more yellowish along edges of segments, with a large black spot on head, becoming blue over the eyes. There is a glistening metallic luster to upper surface of body. Eggs blue or red. The male is much paler than female.

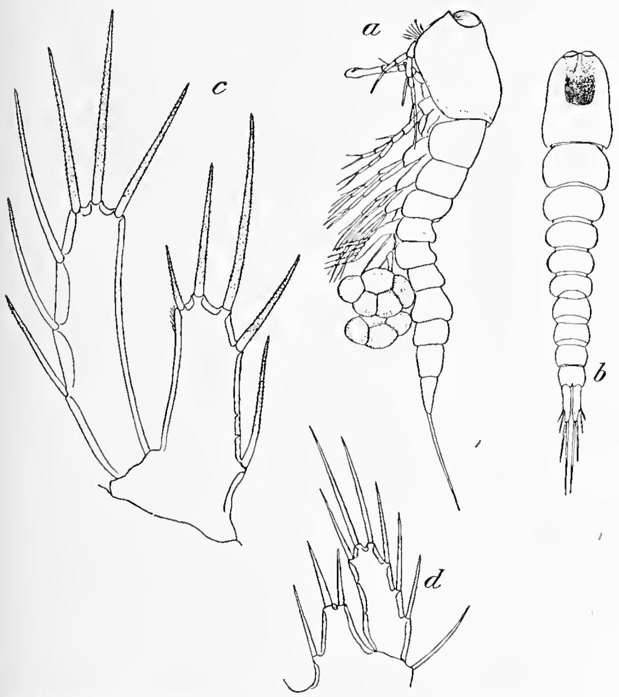
Length of female, 1.75 to 2 mm.; of male, 1.5 mm.

CLYTEMNESTRA Dana.

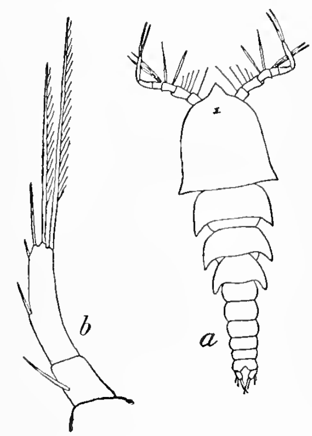
Female: Cephalothorax with 4 segments (head and first thoracic fused), abdomen with 5 segments (first and second abdominal fused); postero-lateral corners of segments in flattened cephalothorax prolonged into projections; furca short. Anterior antennæ 7 or 8 jointed, with short bristles and long æsthetasks. Posterior antennæ 3-jointed (first and second basal joints fused), with rudimental

outer ramus represented by 1 or 2 bristles. Mandible reduced to a stylet-shaped 2-pronged blade; maxillæ and anterior maxillipeds also strongly reduced. Posterior maxilliped 2-jointed, delicate, elongated, with short terminal hooks. Feet with long, slender rami, of which inner are longer; the inner rami of all of the pairs and outer rami of second to fourth pairs 3-jointed; outer ramus of first pair 1-jointed; fifth pair of feet rudimental, 2-jointed.

Male: Differs from female in structure of abdomen (with 6 segments; furcal bristles sometimes elongated), also in structure of anterior antennæ (grasping organs; joints of same number as in the female, but differing in relative lengths; articulation proximal to terminal joint), and posterior maxillipeds (longer than those of the female, second joint stouter, terminal hooks longer).



25. *Miracia efferata* Dana; *a*, ovigerous female, from left side; *b*, male, dorsal aspect; *c*, fifth foot of ovigerous female; *d*, male, fifth foot.



26. *Clytemnestra rostrata* Brady; male; *a*, dorsal aspect; *b*, fifth foot.

26. Clytemnestra rostrata Brady.

Furca at most as long as broad, bristles not plumose, alike in both sexes. Anterior antennæ 7-jointed in both sexes; last joint in female 5 times as long as penultimate; no lancet-shaped thorn on antepenultimate joint in male. Outer ramus of posterior antennæ represented by a single bristle; second basal joint of first foot without an outer marginal bristle, outer ramus of same with 3 bristles, outer ramus of second foot with 1, 1, 2 outer marginal bristles; second joint of inner ramus of third foot longer than third joint. Fifth foot as long as outer ramus of fourth foot, its terminal joint with 5 bristles, which are of same length in male and female.

Coloration: Reddish, owing to distribution through the whole transparent body of numerous pale rose-colored, pale ferruginous-brown or even light-green oil-globules. Eye, deep carmine-red; ovaries dark gray with a reddish tinge.

Length of female, 1 mm.; of male, 0.87 mm.

A few male specimens of this species were collected in the Gulf Stream tow, about 60 miles south of Marthas Vineyard, July 28 and 29, late in the afternoon.

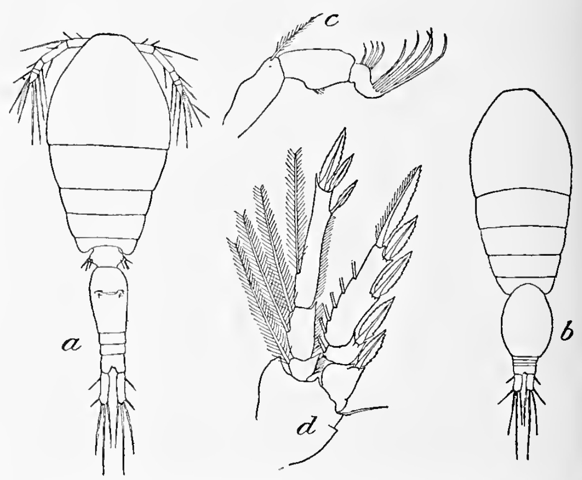
Family ONCÆIDÆ.

ONCÆA Philippi.

Form of body like that of *Cyclops;* cephalothorax and abdomen of female each with 5 segments (head distinct from first thoracic, first from second abdominal). Mandibles not hatchet-shaped, with movable, pectinate and bristle-shaped appendages. The maxillæ are 1-jointed lamellæ. Feet with long, slender third joint of inner ramus, that of fourth pair at least $1\frac{1}{2}$ times as long as first and second joints of inner ramus taken together; fifth foot a small rod or knob. Mouth parts of male similar to those of female.

Female: Anterior antennæ 6-jointed, with long middle joint; æsthetasks poorly developed. Posterior antennæ 3-jointed, with uncinate bristles of medium length. Appendages of anterior maxillipeds in part pectinated with plumes. Posterior maxilliped 4-jointed, on inner border of second basal with rows of points. Outer ramus of first and second pairs of legs with 1, 1, 3, of third and fourth pairs with 1, 1, 2 usually denticulated outer marginal bristles. Inner ramus of first pair with 1, 1, 6, in second pair with 1, 2, 6 (5), in third pair with 1, 2, 5 (4), in the fourth pair with 1, 2, 4 (3) usually bristle-shaped appendages.

Male: Abdomen with 5 segments, with abbreviated middle segments; genital segment voluminous; genital valves with a lateral point. Posterior maxilliped with more movable insertion than in the female, with more muscular second basal joint and more strongly curved terminal hooks; the 3 short terminal joints of anterior antennæ fused to form a single piece; other minor sexual peculiarities.



27. *Oncæa venusta* Philippi; *a*, female, dorsal aspect; *b*, male, dorsal aspect; *c*, female, posterior antenna; *d*, female, fourth foot.

27. Oncæa venusta Philippi.

Female: Cephalothorax pyriform (head broad), usually with granulated cuticle; genital segment but little longer than remainder of abdomen, succeeding segments broader than long; furca at least as long as fourth and fifth abdominal segments together, and at least 4 times as long as broad. Posterior antennæ, especially their inner rami, very short. Terminal hook of posterior maxillipeds with a few points on the concave surface; the 2 bristles on second basal joint rather long and slender. Outer ramus of feet with broad-margined, serrated outer marginal bristles; third joint of inner ramus of fourth pair without terminal pegs, with three lancet-shaped serrated bristles in second and fourth pairs.

Male: Short genital valves and short, broad anal segment.

Coloration: Rather opaque with carmine-red pigment, accumulated largely in the cephalothorax and genital segment, chitin of cephalothorax and appendages more or less violet; eggs blue.

Length of female, 1.1 to 1.27 mm; of male, 0.8 to 0.95 mm.

A few specimens of both sexes collected in the Gulf Stream tow, about 60 miles south of Marthas Vineyard, July 28, 1899, late in the afternoon.

Family CORYCÆIDÆ.

SAPPHIRINA I. V. Thompson.

Body flattened dorso-ventrally; thorax and abdomen of female each with 5 segments (head separated from first thoracic, first from second abdominal), with broadened middle abdominal segments; furca leaf-shaped, each limb with 5 bristles. Mandibles hatchet-shaped, their dorsal tip drawn out into a point. Maxillæ oval lamellæ. Rami of feet 3-jointed of varying relative size; fifth

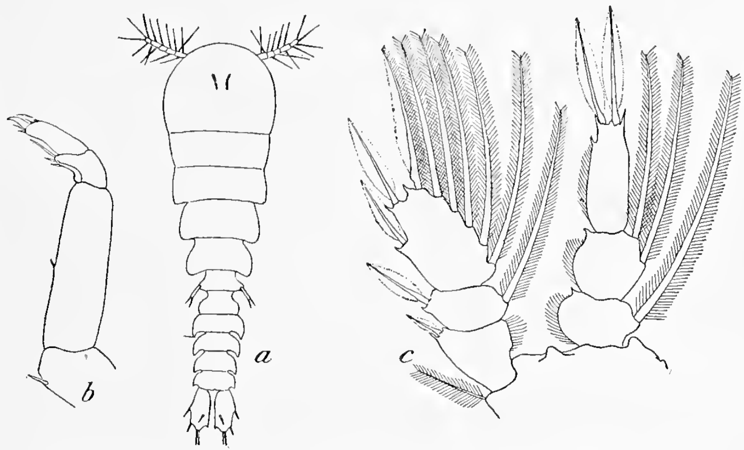
pair rod-shaped, with two bristles. Male with leaf-shaped, broadened body-segments, iridescent; sexual peculiarities in mouth parts and feet not universal.

Female: Eye-lenses contiguous or lying near together; genital orifices pushed up some distance on sides of their segment. Anterior antennæ 3 to 5 jointed; æsthetasks wanting. Posterior antennæ with a short uncinate bristle on terminal joint, otherwise with small, thin bristles. Terminal joint of anterior maxillipeds drawn out into a long point, terminal hook of posterior maxillipeds short and stout. Outer rami of feet with broad-margined, lancet-shaped outer marginal bristles as follows: 1, 1, 3 in first to third pairs; 1, 1, 2 (3) in fourth pair; inner rami of first pair with 1, 1, 6, in second with 1, 2, 6, in third with 1, 2, 5, in fourth with 1, 2, 2 (1) bristles.

Male: Abdomen with 5 segments; genital valves broad, but short, with a few bristles; terminal hook of posterior maxilliped elongated and articulating by means of an intermediate joint with second basal.

28. Sapphirina gemma Dana.

Female: Furca at least twice as long as broad, with a small, sometimes obsolete, point on tip of inner margin; insertion of innermost bristle further back than that of outermost. Eggs blue. Anterior antennæ three-fourths as long as posterior ones, 5-jointed; second joint as long as 3 terminal joints together. Inner ramus of posterior antennæ more than two-thirds as long as second basal joint; terminal claw one-third as long as second joint of inner ramus. Inner ramus of fourth foot somewhat longer than outer ramus; third joint of inner ramus scarcely shorter than first and second joints together, with 2 bristles at its tip.



28. *Sapphirina gemma* Dana; female; *a*, dorsal aspect; *b*, posterior antenna; *c*, fourth foot.

Male: Length of the body about 2½ times as great as its greatest breadth; eye-lenses on ventral surface, front projecting over them some distance. Furca, fourth pair of feet, anterior antennæ as in female, the succeeding appendages in part reduced. Third joint of inner ramus of second pair of feet with 3 lancet-shaped bristles and slightly elongated teeth.

Coloration: "Female colorless; bags of eggs dull bluish. Male with very brilliant blue reflections, dazzling in the sun's rays, with various other bright colors as the animal changes its position." (Dana).

Length of female, 1.9 to 3.1 mm.; of male, 2.15 to 3.1.

Three female specimens collected in tow in Gulf Stream 70 miles south of Marthas Vineyard, July 27, 1899.

According to Giesbrecht *Sapphirina gemma* seems to prefer *Salpa democratica* as a host. My specimens were taken in company with chains of *Salpa cordiformis*.

CORYCÆUS Dana.

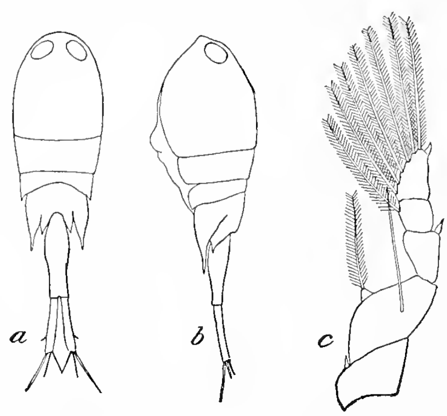
Body cylindrical; cephalothorax with 2 to 4, abdomen with 2 or 3 segments; lateral portions of third and fourth thoracic segments prolonged into pointed projections. Furca rod-shaped, each limb with 4 bristles. Mandibles not hatchet-shaped, with movable appendages, similar to those of *Oncæa.* Maxillæ oval lamellæ. Rami of feet elongated; inner ramus of fourth pair a stub (Stummel) or reduced to a single bristle; fifth pair consisting on either side of 2 small bristles. Body of male not flattened and usually segmented like that of female, never with full number of abdominal segments. Mouth parts not abortive.

Female: Eye-lenses close together, sometimes contiguous; fifth thoracic segment very short. Anterior antennæ 6-jointed, similar to those of *Oncæa*, but with naked bristles and without æsthetasks. Posterior antennæ with voluminous second basal joint and very short first joint to inner ramus; first and second basal joints each with a long, thick bristle and inner ramus with stout, much-curved uncinate bristles. Terminal joint of anterior maxillipeds ending in a strong hook. Second basal of posterior maxillipeds with a bristle on inner margin; its end-hook more delicate than in *Sapphirina*. Outer ramus of feet longer than inner ramus; outer bristles of outer rami in first and second pairs have forms of denticulate lancets (1, 1, 3, more rarely 0, 0, 1) and are more or less abortive in succeeding pairs; inner rami of first pair with 1, 1, 5, in second with 1, 2, 4, in third with 1, 2, 2, in fourth with 1 or 2 bristles.

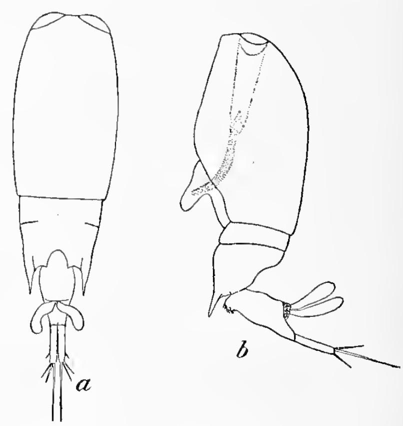
Male: Genital valves long, each with a single bristle; pronounced deviations are shown by the posterior antennæ and posterior maxillipeds, especially in the elongation of the terminal hook.

29. Corycæus elongatus Claus.

Female: Cephalothorax with 4 segments, abdomen with 1 segment; ventral keel rounded; furca between three-sevenths and four-sevenths as long as remaining abdomen. Bristles of first basal joint



29. *Corycæus elongatus* Claus; female; *a*, dorsal aspect; *b*, lateral aspect; *c*, fourth foot.



30. *Corycæus carinatus* Giesbrecht; female; *a*, dorsal aspect; *b*, lateral aspect.

of posterior antennæ but little longer than those of second basal joint. Third joint of outer ramus of first to third foot with 3 outer marginal bristles; inner ramus of fourth foot represented by a plumose bristle.

Male: Boundary between head and first thoracic segment indistinct. Abdomen with 2 segments, posterior portion of genital segment not tapering; furca one-third to one-half as long as remainder of abdomen; tooth on inner edge of second basal joint of posterior antennæ replaced by fine points.

Coloration: Rather opaque, with a variable amount of red, yellowish-red, and yellow pigment, especially in region of mouth, in wing-like extensions of posterior thoracic segments, and in genital segment. Eye red. Eggs yellowish or reddish.

Length of female, 1.45 to 1.65 mm.; of male, 1.3 to 1.4 mm.

A few females taken in tow in Gulf Stream, 70 miles south of Marthas Vineyard, July 28, 1899.

30. Corycæus carinatus Giesbrecht.

Female: Cephalothorax with 2 segments, abdomen with 1 segment; ventral keel beak-shaped, extending backward; abdomen tapering posteriorly; furca half as long as remainder of abdomen, four times as long as broad. Male unknown. Coloration as in the preceding species. Length, 0.85 to 0.9 mm. Several female specimens taken in company with preceding species in the Gulf Stream.

Contributions from the Biological Laboratory of the U. S. Fish Commission,
Woods Hole, Massachusetts.

OBSERVATIONS ON THE LIFE-HISTORY OF THE COMMON CLAM, MYA ARENARIA.

By JAMES L. KELLOGG.

For some years, numbers of small bivalves, attached by a byssus to stones and eelgrass, were noticed along the beaches at Woods Hole, Massachusetts. The outline of the shell was such as to suggest the long-necked or soft clam (*Mya arenaria*), and yet the differences were considerable so far as form was concerned. The whole outline was rounded, and the umbones prominent and widely separated, while in the adult clam the shell is elongated from before backward, the inconspicuous umbones approaching each other closely near the median line. The character of the hinge might have determined the matter, but it was so small and fragile, in the few specimens picked up in the search for other material, that examination was difficult and uncertain. I have long suspected, however, that a study of these forms would show them to be the young of our common clam.

Among the numerous notes and papers by the late Prof. John A. Ryder is a short description of the young *Mya* attached by a byssus.* These small individuals were found in New Bedford Harbor by Mr. V. N. Edwards, of the U. S. Fish Commission. They were attached to floating timbers, together with masses of ascidians (*Molgula*). Professor Ryder, in his study of them, discovered in a few specimens a single byssus-thread arising from a byssus gland in the foot.

Being invited by Dr. H. C. Bumpus, who represented the Rhode Island State Fish Commission, to make some investigations as to the life-history of the clam, during the summer of 1898, I proceeded to Woods Hole, in order to consult with him in regard to the work. Soon after my arrival, it was learned that Dr. A. D. Mead, who had just returned from the Kickemuit River, in Rhode Island, had observed many small bivalves in the seaweed in which were also to be found the small star-fish, which he was engaged in studying. On proceeding to this place, these creatures, which I had previously seen at Woods Hole, were found in countless numbers attached by a byssus-thread to the matted filaments of the marine alga *Enteromorpha*, and rarely to *Ulva* and eelgrass. The *Enteromorpha* was attached to the long blades of eelgrass, and to stones on the bottom, and was found only near the beach, which contained a great many clams. The small lamellibranchs were soon determined to be the young of *Mya*, and the following is an account of their development and habits from the period of their fixation by the byssus-thread to the adult condition.

*American Naturalist for January, 1889, Embryological notes.

SOME STRUCTURAL PECULIARITIES OF THE SMALL CLAM.

Many of the attached forms were extremely small. Several were obtained which were but 0.4 mm. in length, and these the unaided eye could with great difficulty distinguish from fine grains of sand. A glance at fig. 2, which represents an individual of this length, shows a creature with little resemblance to the adult *Mya*. The outline is rounded, and the umbones are very prominent, and project out so as to be widely separated from each other. The foot (*f*) is of the plowshare-shaped variety found in *Venus*, *Unio*, and other clams, and, though not so represented in the figure, may be seen through the delicate semi-transparent shell to extend over the entire ventral surface of the visceral mass. In this it is very unlike the hatchet-shaped foot of the adult *Mya*, which is relatively small, and projects forward from the anterior surface of the visceral mass. The siphons (*s*), however, are similar to those in the adult form, but are excessively delicate and filmy, occupying so little space when retracted that the shell does not gape posteriorly to accommodate them. They are protracted and retracted with the utmost facility and rapidity.

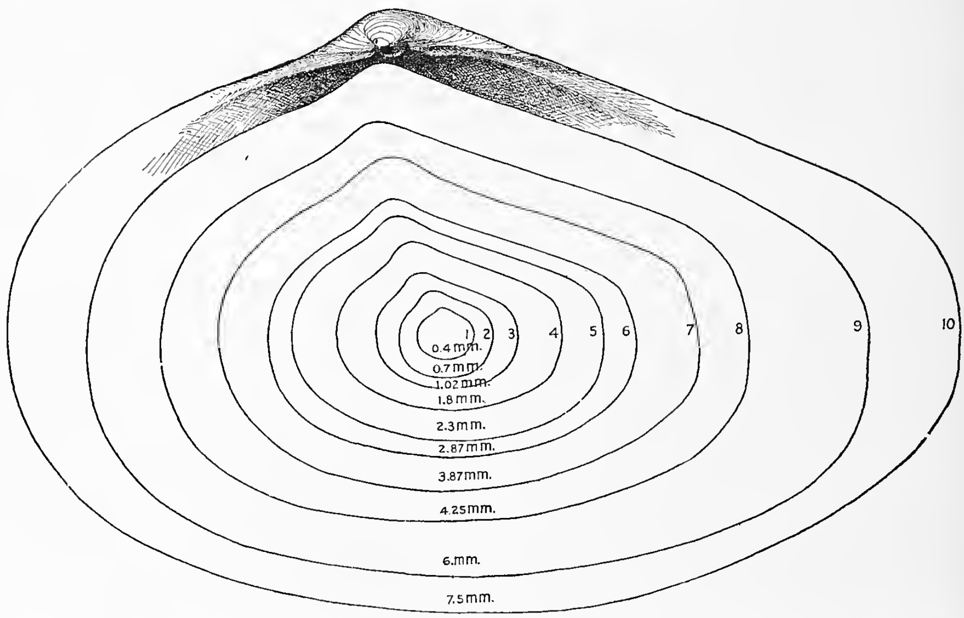


FIG. 1. *Mya arenaria*. Ten camera outlines of shells varying in length from 0.4 mm. to 7.5 mm. They are intended to illustrate the change from a rounded outline in smaller individuals to the elongated condition of older forms. There is at first a more rapid posterior, and subsequently a more rapid anterior, growth of shell, which causes the relative position of the umbo to shift forward, and then back to a position midway between the two extremities of the shell.

It was not difficult to determine that these individuals were young long-necked clams. When arranged in a series from smaller to larger forms, very slight differences between contiguous individuals, as regards the outline of the shell, lead from the rounded form with prominent umbones to the elongated shell of the adult, in which the umbones are inconspicuous. This comparison is illustrated in fig. 1, in which the outlines of the shells of a few individuals have been selected from a large series. They represent forms from 0.4 to 7.5 mm. (less than $\frac{5}{16}$ of an inch) in length. The largest shell differs from that in the adult in having the still conspicuous umbones placed anterior to the middle of the shell, but the general appearance is much the same, and the changes in outline from one to the other are easily followed in intermediate sizes.

In drawing a great many outlines with a camera, two individuals of the same length very frequently presented differences in outline which were considerable. Everyone has probably noticed how great are these variations in form in the shells of the adult clams, even where the shells have not become distorted in growth by coming in contact with unyielding bodies, such as embedded stones. The outlines selected and here reproduced are, of course, representative, and show one or two curious facts which would appear in any similar series. The first of these is that the small rounded shell, as already described, becomes relatively much elongated. Again, in the shell 0.4 mm. in length, the umbo appears near the middle of the shell, and then rapidly shifts its position anteriorly, as the creature becomes older. In outlines 9 and 10 in the series (in individuals 6 and 7.5 mm. in length), the umbones are being gradually moved back toward the middle of the shell, and this is continued in older shells until, as in the adult, they have again assumed a position about equally distant from the anterior and posterior extremities. This shifting in the position of the umbones is of course due to the fact that the shell for a time grows more rapidly posteriorly, and at a later period the anterior part has a more rapid growth.

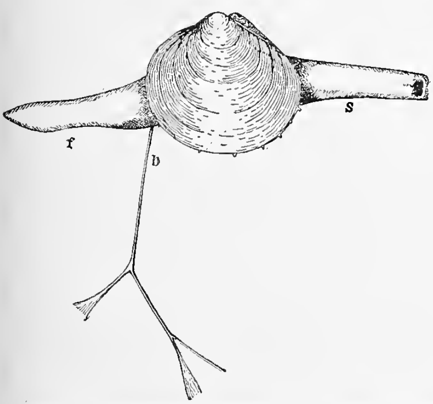


FIG. 2. *Mya arenaria*, with shell 0.4 mm. long, removed from attachment to seaweed (*Enteromorpha*) and showing the single, branched byssus-thread (*b*) arising from a byssus gland at base of foot (*f*). The filmy siphons (*s*) are shown protracted.

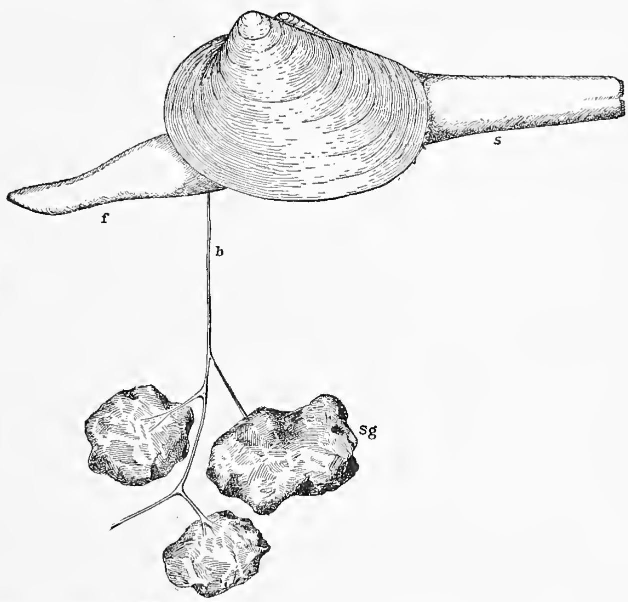


FIG. 3. *Mya arenaria*. Form 2.3 mm. long (drawn on smaller scale than fig. 2), removed from burrow in sand, and showing attachment of byssus (*b*) to numerous sand grains (*s. g.*).

In shells not longer than 2 mm., it is not difficult to detect the usual tooth in the left valve (as well as the excavation in the right), which Gould & Binney describe in the adult as erect, "rounded at its summit, of about equal breadth and height; its inner face is smooth and rounded; its outer face is divided into two portions, the largest of which is spoon-shaped, the other flat, and traversed across the middle by a grooved ridge, which projects beyond the margin of the tooth like a smaller tooth." This description may be easily applied to the small shell. In the smallest forms examined there was a concrescence of the mantle folds similar to the condition in the adult.

ATTACHMENT.

One of the most interesting features of the life-history of the long-necked clam—interesting from an economical as well as from a scientific point of view—is the fact that it is attached by a byssus to foreign objects during a considerable period of its early life. The smaller forms in the seaweed above the bottom were minute in size, some being but 0.4 mm. long. In each there was a well-developed byssus, which afforded a rather firm hold to the filaments of the weed. All the clams in the weed of course maintained their position by the same means, and the largest found, when the first examination was made early in July, was 7 mm. in length (a little more than 0.25 inch). A search early in August revealed several somewhat larger than this, each attached by a byssus, and in the mud of the bottom also many were obtained, some from 10 to 13 mm. long, which still possessed a well-developed byssus-thread.

In the note by Professor Ryder, before cited, a statement in regard to the size of attached individuals is not quite clear. He says:

> As they grew larger it was further supposed that they were held fast in their unusual position by the fibers and cement substances secreted by the mantles of their ascidian neighbors, and thus were suffered to attain a considerable size (from 2 to 15 mm.). * * * However, further investigation showed that in this I was in error, for after a careful search a few individuals were found from which a single byssal thread was found to proceed.

From this statement it does not appear positively that any individual 15 mm. long was seen to have a byssus thread attaching it to a floating body, though such possibly may have been the case.

Beginning work early in July, I was able to find few sexually mature adults in Narragansett Bay or at Woods Hole, the breeding season evidently coming earlier in these localities, probably in May and June; but that some still continue to discharge sexual cells late in July is shown by the fact that even in August there appear on the seaweed a few very small forms, which must be comparatively young.

We are led to the conclusion, therefore, that the free-swimming embryos attach themselves to foreign objects, such as the seaweeds (*Enteromorpha* and *Ulva*), eelgrass, stones, and other bodies, and that these attachments by the minute clam take place in the months of June, July, and August—the great majority of them in Narragansett and Buzzards bays in the latter part of June and in early July. Having become fixed in this way by a byssus thread, the clams remain for some time, many of them attaining a length of at least 6 or 7 mm., and perhaps more.

FREEING FROM ATTACHMENT.

It may be well to notice at this point the fact that the attachment of the clams may be broken at any time, apparently at the will of the animal, by a casting off of the byssus-thread. This is a very usual phenomenon among lamellibranchs with a byssus, and may be well observed in the black mussel, *Mytilus edulis*, where the byssus is very greatly developed. Here, as well as in the young clam, all the threads may be cast off from the gland in the foot, and new threads may be produced at will. Apparently young clams of all sizes in the weed very often perform this act. When they have in this way made themselves free in a glass dish, they at once begin to move about by means of the well-developed foot. Slowly crawling about for a time, they finally reattach themselves, and even after this has been accomplished, they move about in various directions to the length of their tether. In this process of freeing and reattachment, however, it very often happens that the little clams fall from the supporting weed altogether, and reach the bottom. In order to determine, if possible, how fre-

quently this happened, I kept a large mat of *Enteromorpha*, covered with clams, floating in running sea-water. Under the mass was spread some fine cloth. In the course of a week, great numbers—perhaps a fourth of all those attached—were found to have fallen from their support to the cloth, and these were of all sizes. Here they attach themselves, wander about, and again attach, until, apparently tired of the effort to find congenial surroundings, they remain inert, most of them without byssus threads, for long periods of time.

MIGRATION TO THE MUD.

As one would naturally suppose, this period is a critical one for the clam, as much so, probably, as any in its history, though it has to contend with other great dangers which threaten its existence both before and after it enters the mud. The eelgrass on which the *Enteromorpha* filaments grow most abundantly, in the localities examined, is to be found in shallow water, near the clam beds. In falling from their support, most of the clams would probably find a resting-place on the bottom, below the lowest low-tide mark. That this actually happens may be easily demonstrated by taking a little of the mud in these localities and washing it through a fine sieve. When this is done the small clams are often found. But the clams do not depend entirely upon *Enteromorpha* for fixation. As before indicated, they may also attach to stones and other bodies in the water. In the early summer, in certain localities, the floating weed may bear no attached individuals, which are, however, to be found fastened to near-by stones on the bottom. Wherever they may be, they probably free themselves from time to time, and, being below the low-water mark, fewer may reach maturity than if they had been between the tide marks. This is a matter of inference. *Mya* undoubtedly may live in bottoms which are never exposed. I know this to be true, for example, at the salt pond at Wakefield, Rhode Island, and in the river at Essex, Massachusetts, and probably many other such regions are known; but it is difficult to believe that regions below clam flats usually, or perhaps often, bear clams. Clam-diggers very generally seem to know nothing of their existence.

It may be concluded, then, that of the great numbers of small clams which fall to the bottom below low-tide mark, few are able to reach a favorable position higher up on the beach, and the great majority are destroyed. In such localities individuals over 6 or 7 mm. in length are seldom found. While the majority may thus perish, we may well believe that a few, on falling at certain times, are borne by tidal currents above the low-tide mark. They are to be found here burrowed into the sand, or attached to the sides of stones, close to the line where the stone touches the mud. This occurs most frequently on stones covered by rockweed (*Fucus*), and perhaps for the reason that here the little clams find better protection from their most destructive enemies, the young star fish. It is probable that many of these small clams between the tide marks originally attached themselves in this position, never having been fastened to objects in the water below low-tide mark.

This wholesale destruction of individuals below low-water mark is but another example of the tremendous struggle for life to which so many species of organisms are subjected in nature. Of the millions of swimming larvæ that probably arise from one female during a breeding season, few become attached to suitable objects, the water currents carrying most of them away. Those which succeed in fastening themselves are killed in vast numbers by very small star-fish; and even after attaining a position in the sand and mud of a favorable locality, the shifting of the sand, the crowding of individuals, the decay of organic material in the water, or the isolation of salt water

in shallow arms of the sea, lead to the destruction of many. Considering the phases of the life-history of the soft clam thus far described, it seems that artificial methods might be developed which should remove some of the dangers to be found in nature, and hence lead to a greater proportionate increase in the number of adults.

BURROWING INTO THE MUD.

The migration from the point of attachment having been accomplished, we are next concerned with the habit of burrowing into the mud. In the adult clam the foot is reduced to a laterally compressed, fin-like projection from the anterior side of the visceral mass, not extending to its ventral surface. It is with great difficulty that the mature clam buries itself in the sand after having been dug from its burrow. Clams 1 to 2 inches in length will cover themselves gradually in the course of 30 to 45 minutes, but they reach the usual depth of several inches only after a much longer period. Very large clams out of their burrows are still less active. In the young the foot is relatively very much larger than in the adult, and extends from the anterior side of the visceral mass, just under the mouth, far back on its ventral side. This condition of the foot is almost exactly like that to be found in such a clam as the quahog (*Venus mercenaria*) in its mature state. *Mya* has probably descended from an ancestral form which possessed this plowshare-shaped foot, the organ being reduced to its present form because it became less and less an organ of locomotion and was used simply for digging downward into the sand. We have a confirmation of this view in the structural peculiarities of the foot in the very small *Mya*, as described above.

In the young *Mya* the foot is capable of great extension, and is used not only in crawling over objects, but also in digging into sand and mud. It is extremely interesting to notice that individuals but 1.5 mm. long, when placed upon sand, at once attempt to cover themselves by thrusting and worming the sharp anterior end of the foot into it. Unless the sand be extremely fine, clams of this size are not able to thrust aside the grains sufficiently to obtain a lodgment. Those measuring 2 or 3 mm. in length are sometimes able to cover themselves partially or wholly; while one 6 mm. long can usually work its way beneath the surface of any clam bed, and thus rest in comparative security. All clams which I have observed, under 6 or 8 mm. in length, work their way downward only far enough to cover the shell. None of them seem to be very energetic, and often after working long enough to raise the posterior end of the shell to a vertical position, they give up the attempt to bury themselves and remain in that attitude until toppled over by the water currents. After having become completely covered, they exhibit a great deal of restlessness, apparently often push to the surface again, as if dissatisfied with the surroundings, and after wandering about for a short distance once more go down. This process has been seen to be repeated, in an individual 6 mm. long, half a dozen times in the course of three days. They seem to wander short distances—1 or 2 inches only—between the periods of descent, but perhaps the wanderings on the bottom may at times be more extensive.

How large the clam becomes before it digs into the bottom to remain permanently has not been determined. I have frequently found lying on the surface empty shells at least 2 cm. long which had been perforated by the oyster-drill (*Urosalpinx*), and this creature could only have made its attack when the living clam was out of its burrow. Clams of this length, then, apparently have periods of wandering, and it would be interesting to determine, if it were possible, whether or not they would be able to move up between the tide marks from some position below low tide. When

dug out of the beds, clams measuring 2 or 3 cm. in length are generally found to have gone down 12 or 15 cm. (5 or 6 inches) from the surface, the extremely delicate and filmy siphons of the small individual becoming relatively larger and more muscular. There undoubtedly comes a period—probably not far from this time—when the clam ceases to come to the surface, and, except for some accident, remains forever buried, reaching up to the water only by means of the siphon tubes. Evidence of this is the fact that clams are frequently to be found between rocks in such a position that it would be impossible for them to move, having reached such a location when smaller. Then, too, shells, especially the larger ones, are frequently distorted and rendered asymmetrical by coming in contact, in growth, with an unyielding object, such as a stone. The shape in such cases conforms to the space in which movement is possible. This same distortion of the shell may be noticed in other burrowing lamellibranchs, like *Petricola pholadiformis*. In case of this latter form, and also in *Pholas truncata*, which are to be found buried along the edges of salt marshes, the burrow is seen to be surrounded by so dense a feltwork of roots from the marsh vegetation that it would seem entirely impossible that the adult animal could remove itself. It is a mystery how the young could ever force its way into such material.

FIXATION IN THE BURROW.

A peculiar habit, the utility of which is very evident, is the spinning of the byssus by the small clam as soon as it has succeeded in covering itself in the sand. As has just been stated, the small individuals bury themselves, and again appear upon the surface, and this is repeated several times. But whenever the creature goes into the sand, it apparently at once proceeds to pour out the secretion which forms the byssus thread, and attaches itself more or less firmly by this means. Fig. 3 represents a clam with a shell 2.3 mm. long, which has been removed from its burrow. The single byssus thread (*b*) is seen to branch, the ends of the branches being attached to three sand grains (*s. g.*). Actually the number of sand grains and pebbles to which attachment is made is usually much greater than represented. The extremity of the thread which is fastened to the foreign body is considerably widened, as shown in figure. The character of the thread is the same, whether the creature is attached to several sand grains, to a single filament of *Enteromorpha*, or to other bodies. Fig. 2 represents a very small individual, 0.4 mm. in length (drawn on a larger scale than fig. 3), which was attached by several branches of the byssus to one short seaweed filament.

In coming out of the burrow and moving to a new locality, the byssus is cast off at the gland in the foot and left behind, and a new one is constructed at the next descent. This is done within a few minutes. Clams, from the smallest which are able to cover themselves in the sand to those at least 13 mm. long, exhibit this peculiar habit of forming a byssus in the burrow. How much longer the byssus organ remains in functional activity and when it begins to atrophy have not been determined.

The utility of this habit is well illustrated in a circumstance which recently came under observation at the house-boat laboratory, in the Kickemuit Narrows, belonging to the Rhode Island Fish Commission. Suspended in the water was a box filled with sand taken from a neighboring clam-bed. In the sand had been sunken some glass dishes, about 3 inches in depth, which had also been filled with sand. Here a number of small clams were allowed to burrow. On August 5 the region was visited by a terrific windstorm, and everything connected with the house-boat was pitched about furiously for more than an hour. Upon examining the glass dishes afterwards, it was found that all the finer sand had been washed out of them, and but a few small pebbles

remained. On these, however, several clams remained firmly attached, and this had prevented their being washed away. Where the waves were breaking on the beach the same thing was probably taking place. Small clams near the surface in their shallow burrows were probably washed out in great numbers. Many of them were then undoubtedly thrown up and left to perish. I have been informed by clam-diggers that during violent storms, when the tide is high, vast numbers of small clams are sometimes thrown up on the beach and left high and dry to perish by the retreating tide. Thus the possession of a byssus, which is attached to pebbles and sand grains many times heavier than the clam itself, must be of immense advantage in tending to keep the animal from floating off from the bottom.

THE BYSSUS THREAD.

Reference has been made to the relatively large, plowshare-shaped foot which extends backward over the ventral side of the visceral mass. The byssus organ, in which the secretion for the thread is produced, is located in the usual position on the ventral side of the foot, and far toward its posterior extremity. Its position is indicated in figs. 2 and 3, in which, however, the foot is represented as being projected forward to a considerable extent, carrying the byssus organ outside the shell. The byssus itself appears to be made of a single delicate transparent thread (*b*) sometimes bearing a number of side branches, the end of each branch forming a point of attachment. The precise manner of attachment has not been ascertained, but it does not seem probable that it is effected exactly as in *Mytilus* (mussel) and the young *Pecten* (scallop), in which forms a groove on the ventral side of the foot leads from the opening of the byssus organ out nearly to the tip. This groove is converted into a closed tube, and the fluid secretion of the gland is poured out into it. At the tip of the foot it is allowed to come in contact with the body to which attachment is to be made, and adheres tightly. The groove of the foot is now slowly opened, and the secretion, upon coming in contact with the water, is converted into a tough fiber. In this way *Mytilus* forms a number of threads, which extend out in various directions, all uniting near the opening of the byssus gland.

In the clam, an attachment having been made at a few points, the thread may be greatly elongated by pouring the secretion out directly into the water, where it at once hardens, much as the secretion from the spinning gland of a spider hardens, after its extension, by coming in contact with the air. By fastening a byssus thread from a clam 6 mm. (nearly 0.25 inch) in length to the point of a needle, one is able, by exerting a gentle pull on the thread, to draw it out to a length of 5 cm. (about 2 inches) in the space of about 15 minutes. The secretion is poured out at intervals, but not at any time with much rapidity. The thread thus obtained appears to be single, is very elastic, and is possessed of some degree of toughness.

POINTS BEARING ON THE DEVELOPMENT OF METHODS OF CLAM-CULTURE.

The rapidly diminishing supply of clams in Rhode Island has for some time been regarded with serious concern. Clam-diggers everywhere on Narragansett Bay, whom I have met during the present summer (1898), have given the most discouraging reports. In some localities, where clams were abundant four or five years ago, very few can now be obtained. The culture of oysters, as carried on in Narragansett Bay, Long Island Sound, and elsewhere on the New England coast, has been attended by many great and serious difficulties, and yet it has become, in the hands of enterprising

men, a very profitable business. In localities where it has been impossible to obtain a set of "spat," where the beaches between tide marks may not be used, where an annual rental of $10 an acre must be paid, where the deadly star-fish abounds, and where oysters are purchased abroad and shipped great distances simply to be spread upon the bottom and allowed to grow to a marketable size, the business pays and is thriving. One or two attempts have been made to develop methods of clam-culture in this country, but for various reasons—principally because of a lack of protection by law from the depredations of clam-diggers—they have been discontinued.

From the account of the life-history of the long-necked clam here given, it would appear that it may be possible to develop culture methods which should be productive of much greater results than those obtained by oyster culture. Two or three points elucidated, as well as some facts not yet mentioned, may well be noticed as bearing on the solution of this economic problem.

The habit of attachment.—Probably in many localities it would be possible, as it is in the Kickemuit River, to obtain great numbers of young clams in the early summer by simply gathering floating seaweed to which they are attached and transporting them to localities where conditions should be most favorable for further development.

Though no facts bearing on this point are at hand, it may be possible to bring about an artificial fertilization of the ova of the clam in such a way that the swimming larvæ might be induced to attach to some suitable object which should be convenient to handle when it is suspended in the water containing the embryos. This has been accomplished with some degree of success in the case of the oyster, where artificial fertilization may be brought about with very great ease; but with some lamellibranchs it seems absolutely impossible to induce this union of the sexual cells, and this may be the case with the clam. Even if it were so, sexually mature individuals might be placed in inclosed localities, where large numbers of the young could be collected.

Tenacity of life.—While the adult *Mya* dies quickly in aquaria, the small clams are very tenacious of life. Early in July, 1898, a bucket full of *Enteromorpha*, covered with clams, was taken from the water at the Kickemuit Narrows at 11 a. m. of a hot day, and was carried to Woods Hole, arriving at 4 p. m., the water in the bucket having become very warm. The clams were transferred directly to the much colder sea water in the hatching-house of the U.S. Fish Commission station. None of them seemed to be in the least injured by their rough treatment, and they lived in very slowly running water for over a month, when they were removed. In this case, no care having been taken to make the conditions favorable, they did not seem to thrive, and certain individuals measured from time to time showed little or, in some cases, no growth. Others, after remaining a month in the hatching-house, were placed in small glass dishes, which were allowed to stand until the water had nearly evaporated and a zooglea mass had formed on top of it, and they remained alive under these conditions for many days. These facts seemed to indicate that the small clams are very hardy and that, if desirable in culture work, they could easily be transported without injury.

Effect of waters of differing degrees of salinity.—In the transfer of clams just mentioned, it may be noticed that the salinity of water in the two localities is somewhat different. In the Kickemuit the average salinity is about 1.019; at Woods Hole, about 1.024. As is the case with oysters, clams will live in water which is brackish. At the salt pond near Wakefield, Rhode Island, for instance, the salinity is from 1.0049 to 1.0058 on the surface, and quite a number of clams are found along its shores. The density at the bottom may be much greater than at the surface, however.

Enemies.—One important fact which must be considered in developing any method of clam-culture is that the clam in its attached condition, and when exposed on the surface of a bed, is destroyed in vast numbers in many localities by one or two natural enemies. The worst of these is that curse of the oyster-culturist in northern waters—the star-fish. Many extremely interesting and important observations in regard to this creature's habits of destroying clams and other forms have been made during the past summer by Dr. A. D. Mead. These observations show that the star-fish, even when minute in size, is terribly destructive to the young clams.

Another enemy of the young clam is the oyster-drill (*Urosalpinx*). Many clam shells have been taken from the surface sand of the bottoms which exhibited the clean perforation filed by this creature. Shells so pierced were from 3 mm. to 2 cm. or more in length. As I have never found drilled shells in any great numbers in one locality, it would appear that the clam is not seriously menaced by this foe. The adult clam, deep below the surface, is probably not disturbed by other enemies than man.

SUMMARY.

To recapitulate the principal points established in the foregoing description of the life-history of the clam, beginning after the swimming larval condition, we notice that the breeding season in Narragansett and Buzzards bays probably extends through May and June into July. Beginning my observations late in June, I have not been able to determine its limits with any certainty. After the free-swimming larval period, the young clams attach themselves by means of a byssus, which is produced from a byssus gland in the foot. Attachment is made to various bodies in the water. Clams may be found so attached from the latter part of June to the 1st of August. They are to be found in certain localities in immense numbers. The attached individuals measured varied in length from 0.4 to 7 mm. The shape of the smaller individuals differs greatly from that of the adult in being much more rounded, with umbones widely separated laterally. As they become older, they gradually assume the outline which characterizes the adult, but in so doing the umbones come to be situated relatively far forward, and then again move back toward the middle of the shell on the dorsal side. This shifting in the relative position of the umbo is due to a more rapid growth of the posterior, and subsequently of the anterior ends of the shell.

In the smallest forms examined, the mantle folds were in concrescence ventrally. The foot is relatively greatly developed, extending over the entire ventral side of the visceral mass. The siphons have the general characters of those in the adult, but are filmy and may be retracted within the shell with very great quickness.

Clams of all sizes apparently free themselves from their attachment. The byssus is cast off and the creature climbs from one point to another by means of the foot, sometimes reattaching, sometimes falling free to the bottom. In the sand, unless it be excessively fine, individuals less than 2 mm. in length are rarely able to cover themselves, though they always make the attempt. Those 5 or 6 mm. long are apparently able to burrow beneath the surface of any clam shore.

Having attained a lodgment in the sand, all clams observed proceed immediately to form a byssus thread, which is attached to sand grains and pebbles. This tends to secure the creature, so that, even if water currents or the action of the waves should dislodge it from its burrow, it would not be carried so far from its original position as would otherwise occur. Of their own accord, these clams frequently leave the first burrow, wander about, and form another, some individuals repeating the process many times. A time finally comes when they dig into the sand to remain permanently.

Contributions from the Biological Laboratory of the U. S. Fish Commission, Woods Hole, Massachusetts.

THE NATURAL HISTORY OF THE STAR-FISH.

By A. D. MEAD, Ph. D.,
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The investigation of the habits and life-history of the star-fish has been carried on at the suggestion and under the auspices of the Rhode Island Commission of Inland Fisheries. The observations were made principally at the Kickemuit River, Rhode Island, where a houseboat, moored over one of the oyster-beds, served as a floating laboratory. Through the courtesy of the U. S. Fish Commission in extending to me the privileges of the Woods Hole Station and in giving me the use of one of the steam launches I was able to make observations upon the star-fish in other portions of Narragansett Bay and to extend the work into Buzzards Bay. From oystermen I have received valuable information and assistance, and on every occasion the kindest treatment. The report is presented in the form of questions and answers, the questions being such as would be propounded by a practical oysterman, and intended to bring out information of value in combating the ravages of the star-fish. This paper, in slightly different form, appears in the twenty-ninth annual report of the Commissioners of Inland Fisheries for the State of Rhode Island, January, 1899.

IDENTIFICATION AND DISTRIBUTION OF THE STAR-FISH.

I. *Does the animal known to our fishermen as the star-fish or five-finger belong to one or to several species?*

It is evident that if there are two or more species artificial or natural agents destructive to one may prove quite harmless to the others. There are in Narragansett Bay 4 species of star-fishes, out of the 800 or more which are known to occur the world over. They are: The common star-fish (*Asterias forbesii*); the purple star-fish (*Asterias vulgaris*); the blood star-fish (*Cribrella sanguinolenta*); the snake star-fish (*Ophiopholis aculeata*). Only the first two species are considered in this report. The last two are so distinctly different from each other and from the first two that there is no difficulty in identifying them; neither is harmful to the shell-fish fisheries.

The common star-fish and the related purple star vary so much with regard to color, shape of arms, size, number of species, etc., that the French naturalist Perrier has made five distinct species of *Asterias* to include those star-fish along our coast which according to American naturalists, L. Agassiz, Stimpson, and Verrill, belong to two species only. I have endeavored during the last year to ascertain whether some of these varieties were to be explained as a difference in sex, but have been unable to discover any such relation, and am not able to distinguish males from females except by the sexual products.

II. *What is the geographical and bathymetrical distribution?*

The reply to this question will indicate the area subject or most liable to invasion. The purple star ranges from Labrador (probably farther north) to Cape Hatteras, and is most common north of Cape Cod. The common star ranges from Maine to the Gulf of Mexico, and is the species most common south of Cape Cod. The bathymetrical distribution of the purple star is from high water to 208 fathoms, and of the common star from high water to 20 fathoms.

From the numerous dredging expeditions of the U. S. Fish Commission launches and the steamer *Fish Hawk* carried on in 1898 it appears that in Narragansett Bay the purple star-fish (*Asterias vulgaris*) is practically restricted to the lower portion of the bay, below Gould Island, though occasionally, perhaps, taken farther north. One, for instance, was taken near Dyer Island, among 1,000 or more of the common species. I have never known a single one among the thousands of bushels of star-fish captured on the oyster-beds in the upper half of the bay. The common star, on the other hand, occurs in greater or less abundance everywhere from Fox Point to the mouth of the bay, and is the only species that commits depredations upon our oyster-beds. (The purple star would doubtless be destructive if it were present.) The stars from the vicinity of the oyster-grounds are, moreover, very similar to one another in appearance, as compared with those collected in one locality at Woods Hole, where one haul of the mops may bring up stars which apparently belong to several quite different varieties.

There are other varieties differing from those on our oyster-beds and from the purple star, which seem to be characteristic of certain localities. Thus, at the head of Buzzards Bay, at Neys Neck, a large number of common stars were collected, which were very similar to one another, but quite different from those on our oyster-grounds. They had very large coarse spines and were of a bronze color. The specimens taken by the *Fish Hawk* in waters south of Narragansett Bay seem to constitute a variety (maroon star) which occupies this area to the exclusion of other kinds.

It is not known certainly whether each of these so-called varieties is an actual variety in the sense that the individuals breed true, or whether the peculiar appearance is due merely to the fact that the individual stars are bred and reared in a particular locality. If it should prove to be true that the young of a certain variety, e. g., the maroon star, are always like the parent stars, no matter where they grow, we might be able to determine to what extent the star-fish are dispersed while in the free-swimming larval condition.

MODE OF LIFE.

III. *What is the method of locomotion? (It is possible that some barrier might be arranged that would limit, if not prevent, invasion.)*

The star-fish crawls or glides over submerged surfaces by means of the very numerous "suckers," or feet, which protrude from the furrows on the under side of the arms. Small stars, $\frac{1}{2}$ inch or less from tip to tip, are frequently seen, ventral side uppermost, moving along with their suckers reaching up to the surface of the water. This performance can be carried on only when the water is very quiet, and is not often observed outside the aquarium. The buoyancy of the water and the great number of sucking feet enable the animal to crawl over the softest silt and the smoothest hard surfaces with ease, while the remarkable suppleness of the body enables it to get through incredibly small crevices. Besides this ordinary mode of locomotion, another

peculiar method has been aecredited to the star-fish by many, namely, that of elinging together in great clusters and rolling along the bottom with the tide.

The tradition is that large numbers of stars cling together to form a compaet ball from 1 to 3 feet or more in diameter, whieh is rolled along the bottom by the tide until, striking an oyster-bed, the ball goes to pieees and the stars begin work at onee. It is diffieult to find an aetual eye-witness of this phenomenon, though Ernest Ingersoll tells of an old oysterman, "Captain Eaton, of New Haven, who said that he and his brother once raked up the end of a cylindrieal roll of star-fishes elinging tightly together, whieh they hauled into their boat until it would contain no more, when they had to break the roll or 'string,' as he ealled it, which was a foot or more in diameter." The "string" was composed only of star-fishes. I have never observed anything to confirm in the slightest degree the truth of these stories, though I have seen balls of star-fish elinging to each other. Upon examination it was evident that the stars were all endeavoring to devour some animal held in their midst.

For the purpose of testing the ability of star-fish to creep over soft surfaces, vaseline was smeared thickly on a vertical glass plate and on the under side of a horizontal glass plate. These plates were submerged in the aquarium with the star-fish, whieh measured 2 or 3 inches from tip to tip. The animals were observed to erawl over both these surfaces with no apparent difficulty. Paraffin was used in the same way and with the same result. It would appear, therefore, that submerged surfaees, though ever so soft or slippery, would not be effective barriers against the invasion of stars. They will not crawl out of the water, nor even protrude an arm above the surfaee, but will move along over a surface covered with a very thin layer of water, even if it is not deep enough to eover the whole body. They are perfectly seeure, therefore, in a dish of water as shallow as a soup plate, so long as the water does not flow over the edge; but if placed in an aquarium which is eonstantly overflowing, they will frequently erawl over the edge and down the outside. No barrier, therefore, over whieh even a thin layer of water is flowing would be effeetive.

IV. *To or from what distance may star-fish migrate?*

This is a problem whieh has a decidedly praetieal bearing, but we have as yet very little accurate data for its solution. I have been told by several oystermen that stars sometimes suddenly appear in great numbers upon oyster-beds, and move over them at the rate of $\frac{1}{4}$ mile per day, more or less. It is generally understood, also, that there is some sort of a seasonal migration, especially notieeable in spring and fall, but the character and extent of this migration, if it really oeeurs, is unknown.

If a star crawled constantly in one direetion at the rate of 6 inches per minute, whieh is a fair rate for a medium-sized one, it would travel about 4 miles in a month. At this rate star-fish could go from one end of the bay to the other in the eourse of the summer. But there is no good evidence that they take such extended exeursions. The faet that they ean be found all the year round in the upper part of the bay, and on the oyster-beds, shows that there is no wholesale migration to great distanees.

There are some other facts which seem to indieate that the wanderings of these animals are rather limited in extent. Certain kinds of star-fish which are eommon in one part of the bay are not found, or are rare, in other parts. The purple star and "maroon star" do not migrate into the upper half of the bay, although the purple star, at least, might live in these waters, as I have found by keeping them in eonfine-

ment. The star-fish in two neighboring parts of the bay, namely, Mount Hope Bay and Kickemuit River, do not seem to migrate back and forth, for those caught in Kickemuit River, during the past two years at least, were for the most part small, rarely measuring more than 3 inches from center of disk to tip of arm, yet about a mile from the mouth of this river there have been great quantities of very large stars with arms 4 inches long or more. In Barrington River there seems to be a great preponderance of small stars, about $2\frac{1}{2}$ inches (arm) or less, of a reddish-brown color and thus distinguishable from the average star-fish caught in the vicinity of Nayatt. After the great freshet in the spring of 1888 nearly all of the star-fish in the Kickemuit River perished, Mr. Bourne tells me, and were not again troublesome for three or four years.

These facts, though not conclusive, lead to the conjecture that natural barriers to the migrations of star-fishes exist in our bay. Some of these may be, depth of water, density of water, or a strip of barren bottom. If the conjecture is correct, that the migrations of the star-fish are confined to comparatively limited areas, the prospect of diminishing their numbers by a systematized effort is encouraging.

V. *What animals are devoured by the star-fish for food? If the young star-fish feed habitually upon certain animals, it is possible that the destruction of the latter will cause the former to perish.*

Star-fish, especially when young, are exceedingly voracious feeders, prey upon oysters, clams, mussels, barnacles, various kinds of sea-snails (including oyster-drills), worms, and small crustacea, and, if slightly pressed by hunger, turn cannibals and prey upon smaller star-fish. From its depredations upon the oyster-beds of New England the star-fish has become notorious. Collins (Notes on Oyster Fishery of Connecticut) estimates that in 1888 the damage done to the beds in the Connecticut waters alone was $631,500, although 42,000 bushels of stars were taken from the beds that year.

It was found during the summer of 1898 that the star-fish in Mount Hope Bay and in the vicinity of Nayatt were feeding in great numbers upon a little bivalve which closely resembles a young quahog, but which is an adult mollusk of another species (*Mulinia lateralis*). Fig. 1 represents a large specimen, natural size. The *Fish Hawk* recently found these animals exceedingly abundant in certain parts of the bay.

Mussels are a favorite food of the stars, and doubtless many thousand bushels of mussels are devoured by them every season. Indeed, some of the mussel beds have disappeared within the last few years, having been destroyed, probably, by the stars. Unlike the oyster-beds, the mussel-beds are not protected from the onslaughts of the stars, and we can appreciate the extent of the damage to the mussel, if we imagine the condition of a bed of small oysters unprotected from star-fish for a single season.

In rearing the young stars for the purpose of studying their rate of growth, etc., I found them to be very fond of small clams and barnacles, as well as of young oysters. A more detailed reference to the damage done to young clams by the star-fish will be found on p. 215. I have caught stars in the act of devouring oyster-drills, and believe it probable, therefore, that the drills, which are a serious menace to the oysters in some localities where the star-fish are rare, are to some extent held in check by the stars.

VI. *What is the method of feeding?*

The mouth of the star fish is in the center of the disk on the lower side of the body. Comparatively small pieces of food are taken into the stomach, and the refuse ejected again through the mouth. But, since the mouth is small (about $\frac{1}{4}$ inch in a

good-sized star) and surrounded by calcareous plates, larger animals, which form the greater part of the star-fish bill of fare, are necessarily digested without being taken in through the mouth. The stomach therefore is turned inside out and, wrapping itself about the animal to be devoured, digests it where it lies, and is then withdrawn to its normal position within the body. It is safe to say that the stomach can be protruded for a distance equal to the length of the star-fish's arm.

The greater part of the animals upon which the star-fish prey are mollusks protected by hard shells; for example, the sea-snails, mussels, quahogs, and oysters. How does the star get at the soft part of the mollusks? This question has given rise to a great deal of interesting, not to say amusing, speculation, especially with respect to the oyster. An old tradition in England and this country is to the effect that the star takes the oyster by suprise and puts an arm into its gaping shell; then a fight ensues. Sometimes the oyster is victorious, while the star-fish retreats minus an arm, but often the oyster succumbs, since it can not live long with its shell open, and the star then devours its prey at leisure. There are two facts that are sufficient to disprove this theory. In the first place, the oyster is very sensitive and feels the slightest disturbance in the vicinity of the margin of the open shell. In the second place, the shell does not open wide enough to admit the arm of the star. Moreover, simple observation of the star-fish during the process of eating disproves the story.

It is supposed by many that the star-fish injects a poison into the shell which causes the latter to open. But the valves of the shell can be shut water-tight and would exclude such a poison. I have taken away from the star-fish oysters, mussels, and drills which had already been opened, and placed them in an aquarium, where they soon recovered and behaved as though nothing had happened. Schiemenz found the same to be true in the case of the quahog (*Venus*).

Some have supposed that the star bores a hole through the shell of the victim, but the star has no boring apparatus, and the shells known to be opened by the star have no holes in them.

It is a very common belief that an acid is secreted by the star, which dissolves the shell so that an entrance is effected. After a successful opening, however, the litmus paper shows no acid from the stomach of the star-fish, and the margin of the shells shows no trace of having been acted upon by an acid. A considerable quantity of acid would be required to sufficiently dissolve the shell of a medium-sized oyster, and this would undoubtedly dissolve, at the same time, the unprotected calcareous spines about the mouth of the star-fish itself.

The most prevalent opinion is, perhaps, that the star chips away the thin edges of the shell until an entrance is gained to the soft parts. The broken edges of oyster shells which have been opened by the star seem at first to sustain this opinion. The process is thus described in a Providence newspaper:

> The star-fish seizes its prey by clasping its tentacles around the soft, fringy edge of the oyster, which it eats away until the soft oyster can be sucked from the orifice, etc.

Ingersoll, in an article on the oyster industry, after speaking of the alleged use of acid in opening the shell, says:

> Moreover, it seems unnecessary, since the appearance of every shell attacked at once suggests the breaking-down, chipping-off movement, which the star-fish might easily produce by seizing and suddenly pulling down with the suckers nearest the mouth, or by a contraction of the elastic opening of the stomach. At any rate, the thin edge of the shell is broken away until an entrance is made which the oyster has no way of barricading.

An oyster which has not been injured by rough treatment has the edges of the shell extremely thin and so fragile that they can be broken down with a camel's hair brush. The lower shell is particularly fragile near the edge. It will be noticed, however, that the valves frequently do not come together at all at the extreme edge, and the real line of contact, the biting edge, is one-fourth inch or more further back. The chipping of the margin of the shell by the star-fish is merely accidental, and avails nothing in getting at the soft parts of the oyster. I have carefully examined a large number of shells of oysters known to have been devoured by star-fish, and, though they appear to be badly chipped, the biting edge is never broken, and the shells have always been found to be water tight. If such a shell, recently opened by the star, be filled with water, and the valves held between the thumb and the finger, the water will not leak out even though the shell be violently shaken.

In mussels which have been opened by the star-fish there is no trace of any chipping at all. The reason is plain: the valves of the shell come together firmly at the very edge; there is no delicate fringe at the margin. The same is, of course, true of the quahog. Nevertheless, the small quahog and mussel are readily opened by the star-fish. It follows, therefore, that if the star gains entrance to the soft oyster by chipping off the edge of the shell, a different process must be adopted in entering a mussel or quahog, to say nothing of the snails which it also devours.

The credit of solving the problem—How do the star-fish open oysters?—is due to Dr. Paulus Schiemenz of Hanover, Germany, who carried on his investigations at the famous zoological station at Naples. The problem was suggested to him by Collins's report of the enormous injury done to the oyster-beds by the star fish in Long Island Sound. The process is briefly as follows: The star-fish so covers his victim that the suckers on the under side of the arms are distributed, part to one valve, part to the other, and the remainder frequently to some surrounding object. (In the case of the snails the suckers are attached to the operculum and to the shell.) The suckers are very numerous and stick fast, and a tendency to straighten the arms results in a constant pull on the shells in opposite directions, which, if strong enough, would open the shells. It is true that a star-fish is not strong enough to open an oyster or quahog immediately in this manner, but it can and does fatigue its prey. The constant, steady pull in opposite directions soon fatigues the muscle which holds the shell together, and the oyster or clam presently gapes open. The oyster can overcome a strong pull for a short time, but not a weaker pull for a long time. The same principle is well illustrated in the case of the periwinkle or conch. If a string be tied around the "foot" so as to give a good hold on the animal, a strong man can not pull the mollusk out of its shell, but if it be suspended by this string it can not sustain for a long time even its own weight. On the same principle a man who can hold at arm's length a weight of 20 pounds can not hold his empty hand in this position for 10 minutes. Schiemenz showed by experiment that the star-fish could exert a pull of over 1,200 grams, and that a pull of 900 grams is sufficient for opening a good-sized quahog if allowed to act for 30 minutes.

Often more than one star takes part in opening an oyster, and when opened other stars often enter into the feast. It is the young oysters that are in greatest danger from the stars, and the danger decreases as the oysters grow larger. Oysters of marketable size, that is, three or four years old, are comparatively unmolested. Of course the larger stars can open the larger oysters, but fortunately the larger ones are more easily caught in the "mops" and thus more easily kept off the beds. It has not been ascertained how large an oyster can be opened by a star-fish.

VII. *At what season of the year do the star-fish spawn? If at a particular season, a special effort should be made to kill the animals before spawning, and thus destroy both stars and spawn.*

I have attempted by two methods to determine the spawning season of the star-fishes in the upper portion of Narragansett Bay and at Woods Hole. The first method consisted in examining a large number of adult stars at intervals during the year, to see if they contained ripe eggs and milt. The second method consisted in dragging a fine silk "tow net" at the surface of the water, to catch the free-swimming young.

Most of the adult star-fishes examined were obtained through the kindness of the oystermen in Kickemuit River, Mount Hope Bay, and the vicinity of Rocky Point. On July 19 and 22, 1897, 630 stars were carefully examined, and the sizes of specimens and of sexual glands were tabulated. The specimens ranged from $1\frac{1}{4}$ to $3\frac{1}{2}$ inches (taking distance from mouth to tip of arm). Fifteen contained eggs or sperm apparently ripe. In some, only one arm contained ripe products. None of these apparently ripe specimens were smaller than 2 inches. In the great majority the sexual glands were small, less than one-half the length of the arm. During the remainder of the summer, stars from these localities were frequently examined, and occasionally one was found with ripe eggs, but there was no general increase in the size of the glands.

On November 15 a lot of stars from Rocky Point was examined. They were nearly uniform in size, and measured about 3 inches. In about half of these specimens the glands were half the length of the arm, but none were ripe. Among the 75 specimens, measuring approximately 3 inches, collected at the same place November 29, 14 seemed to be nearly mature; the glands in 44 others were half the length of the arm; the remainder had small and immature glands.

January 6, 1898, Rocky Point: About 40 stars, $3\frac{1}{2}$ to 4 inches in length, were examined. Only 4 had sexual products which seemed to be nearly ripe, while the majority seemed less mature than in November.

January 7, Kickemuit River: 50 stars ranging between $2\frac{1}{2}$ and $3\frac{1}{2}$ inches (4 specimens measured 4 inches). In 20 specimens the glands were considerably developed, but not nearly ripe. In the remaining 30 they were quite small.

January 15, Kickemuit River: 50 stars, measuring from $2\frac{1}{2}$ to $3\frac{1}{2}$ inches were examined. In general, there was, perhaps, a slight increase in size of glands, though in over 30 they were very small.

February 9, Rocky Point: 126 stars, $2\frac{1}{2}$ to 4 inches long. In 3 the sexual products were ripe; in 10, nearly ripe; in 53, large and turning color, becoming slightly pink; in 47, small, but showing signs of seasonal development; in 12, very small.

February 12, Kickemuit River: 63 specimens, measuring from 2 to $3\frac{1}{2}$ inches. In 6 the glands were large and beginning to show a pink color; 39 showed seasonal development, while 18 were very small.

March 4, Kickemuit River and Mount Hope Bay: 39 specimens, $2\frac{1}{2}$ to $3\frac{1}{2}$ inches in length; 1 was apparently quite ripe; 26 seemed nearly ripe; the glands in 7 were beginning to change color; in 3 immature but showing seasonal development; in only 2 specimens were the glands very small.

March 7, Rocky Point: 99 specimens, measuring 2 to $3\frac{1}{2}$ inches; 5 were apparently fully ripe; 71 nearly ripe (very large glands); in 20 the glands showed the pink color slightly; in 2 the glands were small, but showed seasonal development; only 1 had very small glands.

It is evident that, during the latter part of January and throughout the month of February, there is a regular increase in the size of the sexual glands in nearly all the star-fishes from Rocky Point, Mount Hope Bay, and Kickemuit River. By the end of the first week in March, the great majority appear to be nearly mature, while the others, except in a few cases, show a distinct seasonal growth in the sexual glands. The stars at this time begin to look "fat," because of the increased size of these glands and of the digestive glands, usually called the "liver," which fill the arms.

April 5, Rocky Point: 197 specimens examined, varying in length from 2 to 4 inches; 137 had the appearance of being fully ripe; 32 were nearly ripe; in 20 the glands were beginning to show the pink color; in 9 they were smaller, but showed seasonal development; in 1 only were the glands very small.

April 13: 25 specimens, out of a basketful from Mount Hope Bay, were examined. All seemed ripe, and so the examination was not carried further. Although during the first two weeks in April the stars are all *apparently* ripe, they do not discharge the products for about two months. During this time they appear to be extremely "fat."

On May 17 the stars were examined again in Kickemuit River and Mount Hope Bay, and appeared very much as in April. They were, perhaps, more distended with spawn and milt, but had not yet discharged.

During the first four days of June, star-fish from many localities in the upper portion of the bay were examined on board the launch *Sagitta*, engaged by the United States Fish Commission. The stars were, almost without exception, full of very ripe eggs and sperm, which were easily shaken loose in the water. Small specimens, measuring in many instances only 1¼ inches, were fully ripe.*

The height of the spawning season occurred between this date, June 4, and June 16. From June 16 to June 28 the star-fish examined in many localities, especially at Kickemuit and Rocky Point, had extruded most of their eggs or sperm, but in some the ripe spawn was found in one of the arms, or merely in the base of the arms, as though not quite all had been extruded. Specimens in which some ripe products were left were more frequent on the 16th than on the 21st, 22d, and 28th of the month, which indicates that the spawning season was rapidly drawing to a close.

Star-fish examined in July, and occasionally during the rest of the summer, yielded the same results as those examined at the same season in 1897; most of them had very small sexual glands, but some were found with products apparently ripe.

On June 22 I searched carefully on the seaweed and eelgrass in Kickemuit River for very young stars, but not a single one (under one-half inch or more) could be found. On June 29 another careful search was made in the same locality, and countless numbers of minute stars were found, most of them about the size of the head of a pin. They were clinging by dozens to every spear of eelgrass, and scattered diffusely through the branches of fluffy seaweed, which is abundant in this locality; the larger of them were probably not more than a few days old (since time of setting), as I afterwards determined by watching the growth of those whose exact time of setting was known. Doubtless, therefore, the small stars were absent, and not overlooked, in the search on June 22. I feel sure, therefore, that in this locality the star-fish first begin to set, in considerable numbers, on June 28, or within a day or two of that date.

The first attempt to capture stars in the free-swimming stage of their existence was on June 27, at Kickemuit. The tow-net was dragged at the surface at intervals for two hours in the evening. The weather conditions were unfavorable, as I afterwards learned, and for this reason no young stars were caught. On the

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* See remarks on "Age and size at sexual maturity."

following morning, June 28, a great many fry were swimming at the surface of the water. From this date until July 16 they could be taken at any time, unless conditions were particularly unfavorable. The few larvæ caught on July 16, however, were old, and all of them set in the aquarium during the next 12 hours. After this no more larvæ could be obtained, though the next few days were exceptionally favorable.

It is evident, therefore, that in Kickemuit River the season during which the star-fish larvæ set in considerable numbers began about June 28 and ended about July 16, a period of a little less than three weeks. Allowing that the larvæ set three weeks after the spawn is laid (which is the period given by Ingersoll), we may conclude that the beginning of the spawning season was about June 7, and the end June 28, while the height of the season was the first, and possibly the second, week in June. From the observations of the sexual glands of the adults, it appeared that the greater part of the spawn was extruded between the 4th and 16th of June. The facts, therefore, obtained by both of these methods agree very closely.

From Dr. Seitaro Goto, of Tokyo, Japan, who worked in Mr. Agassiz's laboratory at Newport in 1895, I have obtained the following interesting data. For one or two days before July 15 the larvæ had been very numerous. On the 15th they were decreasing in number, and after July 20 none were found. At Newport in 1895, therefore, the breeding season was nearly the same as that at the Kickemuit River in 1898.

At any time in the year a few star-fishes may be found which contain ripe eggs and spermatozoa, but it is not known that these eggs are laid out of season. If they are, the chance of their becoming fertilized is small. Dr. Goto writes me that a similar phenomenon is seen in a Japanese species of sea-urchin. He is able to obtain ripe eggs and sperm, and to fertilize the eggs artificially, even in the midst of winter, though the species probably does not breed in these waters at that season.

To answer briefly the ninth question we may say: The stars in the upper part of Narragansett Bay, and probably throughout the bay, have a short spawning season, beginning about the second week in June and continuing two or three weeks. The young fry begin to set the last week in June and continue to set until the middle of July. The fact that ripe stars may be obtained in very small numbers throughout the year is of no practical significance, for if they lay their eggs out of season the chances are comparatively slight of their being fertilized.

Observations were made at Woods Hole from March to the end of the summer I is rather difficult to interpret the results satisfactorily, for at no one period were more than a small proportion of the stars at Woods Hole ripe, or even approaching a ripe condition, and, on the other hand, a few ripe specimens could be found at any time. As a rule the sexual glands were very small, like those of the Narragansett Bay stars in midwinter, and it was noticeable also that in such specimens the digestive glands were also unusually small. The latter condition I take to be an indication of poor nourishment, judging from the condition of poorly fed stars kept in confinement as compared with well-nourished specimens. I am inclined, therefore, to assign the failure to breed to the same cause.

In this connection I may observe that in the specimens kept over winter at Kickemuit, with very little to eat, the sexual glands did not approach a ripe condition. An examination of stars taken in February and March from Narragansett Bay shows that by this season of the year they are eating voraciously, shells and even fragments of star-fish being found in their stomachs. In some years the stars have bred in abundance at Woods Hole, but the notes on the time of breeding are somewhat puzzling, as they indicate that the time varies considerably.

VIII. *What are the habits of the "fry" or free-swimming young? The young of many marine animals, while far more abundant than the adults, are much more delicate and easier of extermination.*

The ripe eggs of the star-fish are minute spherical objects, measuring about one-tenth the diameter of the head of a small pin. They are discharged from the female through minute pores near the base of each arm, into the water, where they may become fertilized by the spermatozoa discharged from the male in a similar manner. Each egg, soon after it is fertilized, begins to undergo a long series of changes in form. During the first stages of development there is little or no increase in size, and the egg rests, like a minute grain of sand, upon the bottom. In the course of a few hours, however, the internal changes which have been taking place express themselves. Vibratile cilia appear in certain areas on the surface of the egg, which now begins to rotate, and soon rises from the bottom as a free-swimming larva. Soon after this the mouth and stomach are developed, and the creature takes in food and grows. The growth is rapid, and during the next three weeks, more or less, the larva increases its diameter about 50 times. Meanwhile various internal organs and several long arms, and other external features, are developed. The older fry are called brachiolaria, from the fact that they have so many long arms. One of these brachiolaria of the largest size is represented in fig. 3, much magnified. The natural size is shown in fig. 4, where two specimens are figured, one on either side of the bit of eelgrass. The animal swims by means of the motile cilia, which are arranged in bands, represented by the heavy lines in the figure. They form a complicated pattern over the surface of the body, and extend out upon the arms. The body is quite transparent, and the tips of the arms, which are shaded in the figure, are light red. The larva represented in fig. 3 is old, and would probably have set within 12 hours. Already the rudiment of the resulting star-fish, the disk-shaped body at the bottom of the figure, can be seen within the brachiolarian. The five crenate lobes on the margin of the disk are the beginning of the five arms. The disk itself at this time is already somewhat opaque.

When the larva is about to "set," it attaches itself to some object, like a spear of eelgrass, by the suckers, shown at the top of the figure, and then a rapid transformation occurs. The whole superstructure above the disk collapses and becomes absorbed like the tail of a tadpole. In a few hours the brachiolarian has disappeared, and a star-fish proper has taken its place.

Although the free-swimming larvæ have a considerable power of locomotion, and can swim from one side of a dish to the other in a few minutes, they can not, of course, make headway against the tidal currents, and are carried hither and thither with their ebb and flow. Other extensive movements of larvæ are executed in response to such changing conditions as those of light and temperature; at times myriads of them are swimming at the surface, and in 12 hours not one specimen can be found. The brachiolarian, like more lowly organized forms of living creatures, although it has no eyes, is exceedingly sensitive to light, sometimes being attracted to it, and again being repelled by it. According to my experience, they were found at the surface in greatest abundance on cloudy or misty days and nights, and were much more rare, or absent altogether, on bright, clear days and moonlight nights. On June 27, for instance, I skimmed the surface with the tow-net from 9 until 11 o'clock, and not a single larval star was found, although there were millions of the larvæ of the annelid worm *Syllis*, and other organisms. The night was clear, with a bright moon, and the tide was rising. The next morning, June 28, was cloudy with some rain, and

large numbers of the larvæ were taken in the nets, between 8.30 and 10 o'clock. In the evening of this day, between 9 and 11 o'clock, they were even more abundant than during the day. The evening was calm and cloudy, with a little rain. Afterwards I met with the same experience on several occasions.

Another question in respect to the movements of the free-swimming larvæ is of practical importance, inasmuch as they are thousands of times more numerous than the adult stars. To what distances may the larvæ be carried by the tides and currents in our bay? I can not answer this question directly, but there are certain facts which have an important bearing upon it.

Although the purple stars (*Asterias vulgaris*) are common in the lower portion of the bay in the vicinity of Newport and Seaconnet, they seem to be totally absent from the upper parts, although the adults, at least, can live in these waters. I have kept them for a long time in Kickemuit River. This would seem to indicate that the larvæ of purple stars are not transported by the tides from the lower to the upper portion of the bay. It may be, of course, that the larvæ, unlike the adults, can not abide in the upper portion, or that the young stars, as soon as they can crawl, return to the southward unnoticed; this seems to me, however, to be improbable.

The distribution of some other marine animals whose habits are similar to those of the brachiolaria is of interest in this connection. At Waquoit, about 10 miles northeast of Woods Hole, on the Vineyard Sound side, the water was fairly alive with the young of a certain species of jelly-fish, which could be obtained from this locality in immense numbers at any time for several weeks during the spring. At Woods Hole, however, these specimens were comparatively rare. Again, later in the summer, at Menemsha Bight, near Gay Head, another small jelly-fish was found in such abundance that every bucketful of water contained thousands of specimens, yet they were exceedingly rare, if present at all, at Woods Hole.

In the upper part of Buzzards Bay, at Neys Neck, the star-fish probably bred in great numbers, judging from the appearance of the adults earlier in the spring, yet the larvæ were rarely caught at Woods Hole.

These facts, and others of the same nature, certainly suggest that the larval star-fish may not be transported to great distances in the bay by the tides.

IX. *What are the habits of the young star-fish? It is possible that the young star-fish, like the young of many fish, tend to gather in schools. If so, the young might be killed off in thousands.*

The data with reference to the habits of the young stars were collected at Kickemuit, where it was possible to have a certain area along the shore under constant observation. Up to the very time when the larvæ are ready to set they swim freely in the water; and larvæ, caught in the tow-net, often set in the dish of water before I had returned to the houseboat, i. e., within an hour of the time they were caught. In this condition they attach themselves by their suckers (see fig. 3) to any object they happen to strike, and cling to it with great tenacity until the metamorphosis is completed. As the larvæ are borne along by the currents, the eelgrass, rockweed, and especially the fluffy, branching seaweed, naturally catch immense numbers of them. I think it would not be an exaggeration to say that on a single handful of seaweed which I picked up about the 1st of July there were more than a thousand young stars. For the next three weeks they remain for the most part crawling about over this vegetation, gradually working down among the roots of the rockweed and upon the large stones at the bottom. They grow rapidly during this time, but decrease

in numbers, for they are bright and conspicuous objects for the small fishes; yet they are exceedingly numerous for a long time. In order to obtain a definite expression of their abundance, I scooped up a large handful of the fluffy seaweed, which, together with the water, filled about two-thirds of a paper pail, and from this 603 young stars were taken. The average size was about that in fig. 9. A cart load of seaweed taken out at this time would have destroyed millions of star-fish.

By the 1st of August the fluffy, branching seaweed, which bore so many young stars, was nearly all dead, and though the stars were still present in great numbers upon the eelgrass, rockweed, and stones covered with sea-moss, they were also frequently seen crawling along the muddy bottom. By August 15 the eelgrass was overgrown and lodged by a luxuriant growth of *Botrylus*, a compound ascidian, which appears as dark gelatinous patches. The small stars were still numerous upon it, but were rather thin and poor. The larger and better nourished stars had left the eelgrass and were searching for food upon the stones and along the bottom.

The small star-fishes, such as live upon the eelgrass, are remarkably hardy in some respects. They will live for weeks, and even months, in a small dish, without change of water and with a minimum amount of food. During the first week in July I carried a number of free-swimming brachiolaria, like fig. 3, to Providence for further examination. They were in a glass 1-quart jar, and, after one or two were taken out, the jar was closed and was left unopened during the rest of the summer. In a few days the larvæ had all set, and when I examined the dish again, on September 5, it contained still a few live stars, which were, however, very small. Upon watching them it was seen that the more enterprising individuals were eating their companions, and finally only one remained. This one lived in the jar for weeks, but, unfortunately, I am not able to record the exact date of his death.

On the other hand, the same young star-fishes, which can live so long without food or change of water, perish quickly if left out of the water, especially if the sun is shining. They can not live, therefore, above the low-water mark, unless sheltered by a dense growth of vegetation. Large stars can endure very much longer exposure, since their bulk prevents their drying so quickly. On July 16 I made a special search for young stars on the sea-weed, above the low-water mark. I found none, yet just below low-water mark they were excessively abundant. At the same time it was noticed that above the line where the star-fish were abundant there was a thick set of 1-year old oysters, while below it the oysters were absent. The oysters set somewhat later in the season than the star-fish, and the latter, therefore, are ready to prey upon the young oysters as soon as they appear. When, in addition to these facts, we take into account the extraordinary voracity of the young star-fish, their immense numbers, and their special fondness for oysters, we are led to conclude that one reason why a considerable set of oysters is so rarely obtained below low water is that they fall prey to the star-fish. The oysters which set above high water are comparatively safe, for when the tide leaves them uncovered they can endure for hours the direct heat of the sun, which would kill the young star-fish in a few minutes.

While the star-fish are living upon the eelgrass and seaweed they are supplied with an abundance of food in the form of the young of marine worms, snails, and other animals, which, like the stars themselves, swim freely in the sea for a time, and then settle down upon any object with which they happen to come in contact. Throughout July the water at Kickemuit was teeming with minute free-swimming creatures, and in the aquarium the growth of the youngest stars could be greatly accelerated by feeding

them the contents of the tow-net. During the last four days of June innumerable larvæ of a marine worm (*Syllis*) were swarming at the surface, and on July 11 millions of the young of one of the sea-snails (*Littorina?*) were caught in the tow-nets.

The clam, also, is one of those unfortunate animals whose larvæ set at about the same time as the star-fish, and in the same places. The star-fish before they are 3 days old show a predilection for young clams, which apparently does not diminish so long as any clams remain. Fig. 2 was drawn from life last summer by Dr. J. L. Kellogg, and represents a characteristic scene in the marine tragedy.

In order to ascertain how fast the stars of the average size found upon the eelgrass would devour the young clams of average size, I placed one such star in a dish with 56 clams taken at random from the margin of a stone. The larger clams were about the length of one arm of the star, and they ranged from this length to 1 or 2 mm. The experiment was begun at 1.22 p. m. on July 18; at 5.40 p. m. 2 clams had been devoured, each about the length of the arm of the star, and during the evening a third was eaten. At 8 o'clock the following morning 5 had been eaten, at 9 o'clock 6, and at 9.05 the seventh clam had been attacked. I was absent from the laboratory for the next 4 days, and, returning on the 22d, found at 6 p. m. 29 empty shells whose contents had been eaten by the star, which had grown considerably and was eating faster than formerly. The next day 39 empty shells were found, and on the following day 46 were empty, while 10 more had disappeared altogether, having doubtless been devoured, shell and all, some time during the week. To make sure that the clams were killed by the star and did not die from some other cause, a control dish of clams was kept, in which all the specimens lived. *In six days a single star-fish devoured over 50 clams.* Both star-fish and clams represented the average size at this season. I regret that I did not record the exact dimensions of the star at the beginning of the experiment. Fig. 11 shows its approximate size at the end of the experiment on July 25.

When we recall how exceedingly numerous star-fish are, and that they are found in the same localities with the young clams, the result of this experiment becomes still more significant. At this rate 600 stars from one netful of seaweed could devour 30,000 clams in 6 days. The star-fish in a cartload of seaweed, if it contained 200 small forkloads, would have the capacity for destroying over 6,000,000 clams in a week.

From the foregoing it appears that the star-fish set for the most part during the last few days in June and the first week in July, some as late as July 16. They remain upon the seaweed in immense numbers until about the 1st of August, when many of them are found upon the bottom. By August 15 the greater portion of the stars have left the seaweed and gone to the bottom. The young stars do very great damage, not only to the young oysters, but also to the young clams.

The stars could be destroyed by hundreds of thousands in July by collecting and drying a few cartloads of seaweed taken below low-water mark. After the first week or two of July the collection of seaweed would do no injury to the clams.

X. *What is the rate of growth up to sexual maturity?*

The observations and experiments bearing upon this question were made at the Kickemuit River, and these methods were adopted:

(*a*) A large number of star-fish were kept under constant observation and were surrounded with natural conditions as far as possible.

(*b*) Frequent observations were made on the stars in their natural environment.

(*c*) Individual star-fish were reared under various conditions, and their growth recorded from time to time.

(*d*) Star-fish which were regenerating lost parts were kept under various conditions, to determine the rate of growth and the rate of regeneration.

(*a* and *b*) On June 29 a bunch of seaweed, on which were hundreds of small stars, was placed in a car at the house-boat. All the stars were very small. The greater number were about the size of that in fig. 5, but they ranged from the size shown in fig. 4, just setting on the eelgrass, to that in fig. 6.

On July 15 it was found that hundreds of stars had crawled through the wire netting and were thickly scattered about on the under side of the car. Here they had found an abundance of small barnacles, which to all appearances they very much relished. After preserving a few specimens, to compare with those taken from the seaweed, the rest of the stars were left unmolested upon the bottom of the car. The average size of the stars on the car was greater than the average of the larger specimens on the seaweed. This was doubtless due to the fact that the former were better fed. A difference in shape was also striking, those on the car being more plump. Figs. 7, 8, and 9 represent three specimens taken from the seaweed on this date, and fig. 10 one of the larger specimens (3 mm. from mouth to tip of arm) from the car, all natural size. The measurements which follow are all taken from mouth to tip of arm.

On July 18 the stars showed a very appreciable growth. One of the larger specimens, measuring 5 mm., is represented natural size in fig. 11.

On July 24 one of the largest measured 8 mm., and was preserved (see fig. 12).

On July 26 one could see an appreciable growth since the 24th, and the specimen shown in fig. 13 measures 9 mm. In 11 days (since July 15), therefore, there has been an increase of 300 per cent in the length of the arm, which is equivalent to a much larger increase in bulk.

The stars were taken from the bottom and put inside the car on August 1 and were fed with barnacles and small mussels. They had by this time eaten nearly all the barnacles on the bottom of the car and were doubtless in want of food.

On August 2 the largest specimen measured 11 mm., and is represented in fig. 14. Those on the bottom, however, which had left the eelgrass, were larger, some of them approaching the size of those on the car.

On August 13 a box thickly covered with barnacles was split up and pieces put into the car. The star-fish always preferred the under side of the boards, and the latter were therefore placed barnacle side down.

The stars on the eelgrass were examined on August 15 and the larger ones averaged about 2½ mm., or about the size of that in fig. 9.

On August 18 the largest measured slightly less than 18 mm (see fig. 15). This specimen was afterwards kept in a dish without food, and will be referred to again.

On September 5 one of the largest specimens was 26 mm. in length of arm (fig. 16). Another measured 27 mm., and several measured 25 mm. or more.

On September 26 the largest measured 35 mm., and is represented in fig. 17.

On October 12 the largest found was 42 mm. (fig. 18).

On October 25 one specimen measured 54 mm., or about 2¼ inches (fig. 19); this was preserved. The next largest (51 mm.), shown in fig. 19, is the largest star reared in captivity. It was almost exactly 4 months old, having set about June 28. The sexual glands were more highly developed than usual, even for larger stars at this season. From this date to November 11 there was no growth, but apparently a slight decrease.

The following gives in brief the measurements of some of the largest stars found on the car during summer and fall. The asterisk (*) indicates that the specimen was not returned to the car, so that a smaller specimen was recorded on the next date.

Date.	Milli-meters.	Date.	Milli-meters.	Date.	Milli-meters.	Date.	Milli-meters.	Date.	Milli-meters.
July 15	3	Sept. 5	25	Sept. 26	34	Oct. 12	38	Oct. 25	45
July 18	5*	Sept. 5	25	Sept. 26	33	Oct. 12	36	Oct. 25	44
July 24	8*	Sept. 5	25	Sept. 26	33	Oct. 12	35	Nov. 5	45
July 26	9	Sept. 5	24	Sept. 26	31	Oct. 12	35	Nov. 5	44
Aug. 2	11	Sept. 5	24	Sept. 26	30	Oct. 25	54*	Nov. 5	43
Aug. 18	18	Sept. 5	24	Sept. 26	30	Oct. 25	51	Nov. 5	43
Sept. 5	27	Sept. 5	23	Oct. 12	42	Oct. 25	50	Nov. 5	43
Sept. 5	26	Sept. 26	35	Oct. 12	40	Oct. 25	48	Nov. 5	42
Sept. 5	26	Sept. 26	35	Oct. 12	40	Oct. 25	45	Nov. 5	40

On September 5 a number of specimens (19 in all) were selected and placed by themselves in another car, so that I might be sure to measure the same individuals on succeeding days; these were measured on six occasions, with the following results:

Specimen.	Sept. 5.	Sept. 26.	Oct. 12.	Oct. 25.	Nov. 5.	Nov. 11.
No. 1	24	35	40	47	46	41(?)
2	24	31	35	40	38	41
3	20	30	35	38	38	40
4	19	29	34	38	38	39
5	19	29	33	38	38	38
6	19	28	32	37	38	38
7	18	28	32	36	38	36
8	18	28	31	36	37	36
9	18	27	31	36	37	35
10	18	26	30	36	37	35
11	17	26	30	35	37	35
12	16	26	30	35	37	35
13	16	25	29	35	34	35
14	16	25	29	35	35	35
15	15	24	28	34	33	34
16	15	23	28	32	33	34
17	15	21	27	30	32	33
18	14	21	25	30	32	31
19	12	21	....	29	31	31

It will be noticed that among these specimens, as well as among those in the original car, given in the first table, there is rarely any evidence of growth after October 25, but there is rather a slight decrease in size. On each occasion the measurements were made without referring to those of the preceding date, so that no personal prejudice might enter the results. For the most part the figures indicate a fairly uniform rate of growth among the different stars. In interpreting these figures there is one factor which is to be taken into consideration, namely, that star-fish over 20 mm. (sometimes less) are able to contract and expand, so that two careful measurements, taken within a few minutes of each other, may vary as much as 1 or 2 mm. The measurements in the last three columns, therefore, indicate that the star-fish in the car were of about the same size on November 11 as on October 25. The first measurement (41 mm.) under November 11 is doubtless an error.

It may be inferred, from what has already been said, that at any time during the summer, after the stars are all set, there is a great difference in size among them. To illustrate this point, I arranged on August 18 a series of specimens taken from the car and from the seaweed, and photographed them at natural size, by laying them down on the sensitive paper (with a thin transparent film between), and then exposing. The variation in size is shown in fig. 20, the first 5 specimens having been taken from the car, and the last 5 from the seaweed. This variation in size is doubtless due much more to the difference in amount of food than to difference in age.

The following experiments on the rate of growth support this view:

(*c*) *Rate of growth of individual star-fishes kept under various conditions.*—The largest of the stars in the car on August 18 (compare fig. 15) was kept in a dish with only a few very small barnacles for food. When taken from the car, it measured 18 mm.; slightly more when fully expanded. On September 25 it measured 18 mm., showing no growth. On September 26, 39 days after it was taken from the car, it measured between 15 and 16 mm. In the absence of food, therefore, it had lived and apparently was in perfect health, but had probably diminished somewhat in length, as well as in bulk. (Some allowance must, of course, be made for the contraction and expansion, as mentioned before.) During this time several of the stars, smaller than this one, remained in the car and grew to the length of 35 mm. (Fig. 17.)

A small star-fish which was caught in the tow, and which set on June 28, was kept in the dish with many others until June 23. On this date it was placed in a small dish by itself and fed with small clams and barnacles. Fig. 23 shows the growth of this specimen: *a*, 2 mm., July 23; *b*, 4 mm., August 13; *c*, 4½ mm., August 18; *d*, 5 mm., September 6. On September 6 it was transferred to a car where there was an abundance of small barnacles. Fig. 23, *e* (12 mm.), represents size on September 26; *f*, 21 mm., on October 12; *g*, 30 mm., on November 5.

As a control of this experiment, several star-fish, which also set on June 28, were kept with a minimum amount of food. One of these, photographed at natural size on September 6, is shown in fig. 21 *a*, while the largest star in the car (with plenty of food) is represented in fig. 21 *b* (27 mm.). The specimen figured in *a* is 39 days old, and that in *b* is within a day or two of that age.

The next experiment (illustrated by fig. 22) on the growth of stars was as follows:

On August 3 two stars of average size were taken from the original car and placed in another car with a bunch of mussels.

On August 3 (No. 1) = 7 mm., fig. *a*. On August 16 (No. 2) = 10½ mm., fig. *a*′.

During this time the stars had little or no food, since they could not, or would not, eat the mussels. On August 15 a lot of barnacles was placed in this car, and by September 5 the results of the new food were evident enough:

September 5: (No. 1) = 15 mm., fig. *c* (one arm was torn off in measuring). (No. 2) = 19 mm., fig. *c*′.

September 26: (No. 1) = 28 mm., fig. *d* (new arm 10 mm. measured from mouth, growth of 7 mm.). (No. 2) = 29 mm., fig. *d*′.

October 12: (No. 1) = 36 mm., fig. *e* (regenerating arm, 20 mm., from mouth, growth of 17 mm.). (No. 2) = 41 mm., fig. *e*′.

From August 3 to August 16, while these specimens were not growing at all, those in the car grew about 6 mm. These two specimens afterwards, however, having more food and no interference in eating it, made up this difference, and by September 26 had grown as much as those in the original car.

One interesting point brought out by the experiment is that a star which is regenerating an arm may grow as fast as a complete star. Compare next experiment.

(*d*) *Rate of growth and rate of regeneration.*—The star-fish, like the lobster and many crabs, has the habit of dropping off an arm which has been mutilated and regenerating a new one. Unless the arm is mutilated or some other shock administered, one may sometimes tear a star in two by pulling on the arms, while the latter still remain on the fragments of the disk. On the other hand, if the suckers are cut off from one arm, or the arm is crushed or cut several times, it will usually drop off, always at the same point near the disk, taking the sexual glands with it.

On September 26 five of the larger stars in the original car were deprived of the arm opposite the "eye," or madreporic plate, and then placed in a car with barnacles for food. The subsequent measurements show that they kept on eating and growing at about the usual rate, like the specimen similarly treated in the last experiment described. The measurements are given in tabulated form below, the first measurement indicating the length of the longest arm.

Specimens.	Sept. 26.		Oct. 12.		Oct. 25.		Nov. 5.		Nov. 21.	
	Longest arm.	New growth.	Longest arm.	New growth.	Longest arm.	New growth.	Longest arm.	New growth.	Longest arm.	New growth.
A..........	32	0	36	3	42	7	41	11	40	12
B..........	30	0	35	3	38	7	41	12	40	11
C..........	28	0	30	3	35	7	38	10	38	12
D..........	27	0	29	3	30	6	35	9	38	11
E..........	25	0	28	3	....	....	34	7	35	9

A comparison of the table with that on page 217 shows that these stars which are regenerating an arm grew at about the same rate as the complete stars during the same period. The rate of regeneration was also about the same as the rate of growth in the original arms, except that toward the last the new members grew in some cases somewhat more rapidly.

Another experiment was made similar to the above, except that two arms were taken off instead of only one, and the stars were younger at the beginning. The stars were at first all about 12 mm. The eight detached arms were put in the car also, and on September 10, 26 days after they were detached, five were still alive and apparently in good health, but had neither grown nor shown any sign of regeneration. One is figured natural size in fig. 24 *b*.

The growth of these specimens is tabulated below. (Measurements were made from mouth to tip of new arm, but figures in table indicate merely new growth, and are derived by subtracting 3 mm. from original figures.)

Specimen.	Aug. 15.	Sept. 5.			Sept. 26.				Oct. 12.				Oct. 26.				Nov. 5.			
	Longest arm.	Longest arm.	First short arm.	Second short arm.	Longest arm.	First short arm.	Second short arm.	Newest arm.	Longest arm.	First short arm.	Second short arm.	Newest arm.	Longest arm.	First short arm.	Second short arm.	Newest arm.	Longest arm.	First short arm.	Second short arm.	Newest arm.
a	[1]12 (?)	22	....	8	34	18	17	....	42	32	30	....	....	....	....	....	....	....	....	....
b....................	12 (?)	20	....	7	30	17	17	....	36	26	26	....	....	....	....	....	43	31	31	....
c....................	12 (?)	18	....	5	25	[2]9	[3]9	....	37	16	15	....	....	....	....	....	40	24	24	....
d	12 (?)	18	....	5	23	14	12	[4]8	32	22	20	13	35	23	23	17	34	27	27	20

[1] It was intended at first to keep account only of rate of regeneration, and so four stars were picked out, of about the same size, and one only was measured. This was 12 mm. The others may have been 1 or 2 mm. larger or smaller. The growth of this specimen and the size of the single arm alone, on September 26, are given in diagram, fig. 24, *a* and *b* respectively.

[2] One detached arm, still alive, measures 7 mm.

[3] Tips cut off and arms slit on September 15. The longest arm was then 22 mm., and the regenerating arms 15 and 10 mm., respectively.

[4] Arm broken off, probably by handling, on September 5.

This experiment shows conclusively that when even two arms are lost the growth of the star-fish is not necessarily arrested or the rate of growth diminished. The rate of growth in the new arms was greater than in the original arms, and there was a tendency, therefore, for all to become ultimately of the same length.

The results show clearly that within very broad limits it is impossible to tell the age of a star-fish from its size. Star-fishes of all ages are able to live for months with very little or no food. The rate of growth depends directly upon the amount of food eaten. Star-fishes which are regenerating one, or even two, arms may, under ordinary circumstances, grow as rapidly as the complete stars. The growth of the new arms in the star-fish experimented upon was slightly more rapid than that of the original arms, showing a tendency in the organism to return to the original length. In four months from time of setting, some of the larger stars kept in the cars under favorable circumstances attained a length of from 50 to 54 mm., or 2 to $2\frac{1}{8}$ inches, measured from mouth to tip of arm. This is more than twice the length of many of the stars which were found just before the beginning of the breeding season, and which were therefore at least nearly a year old.

Allowing a moderate amount of growth during the winter and spring months, of 10 to 15 mm. (the amount of increase attained in one full month preceding October 12), the larger year-old star-fish in the early summer would be about 65 mm., or $2\frac{1}{2}$ inches, in length, which is about the length of the greater number of stars taken on the mops in the Kickemuit River during the summer.

XI. *What is the size and age at sexual maturity?*

Among the star-fish caught in various parts of the bay on June 2, 3, and 4, several specimens only $1\frac{1}{4}$ inches, or 32 mm., were found to be very full of sexual products. This size was attained by many of the star-fish reared in the car on September 26, about three months from the time of setting. See table on page 217.* Great numbers of stars measuring about 2 inches, or 50 mm., were found ripe the first week of June. This was the size of several specimens in the car on October 25, which were not more than four months old, and whose sexual glands were well developed. In other words, a large number of the star-fish reared in the car were by the end of October as large as a great many which were sexually mature in June. Moreover, it was rare to find a specimen of this size on the 1st of June which was not full of ripe eggs, which were laid later, as the empty star-fish caught in July showed. It is an obvious conclusion, therefore, that, with fairly good opportunities to obtain food, the star-fish becomes sexually mature in less than a year, and that those hatched one season breed the next.

In his monograph on North American star-fishes, Alexander Agassiz gives his views with reference to their rate of growth in the following words (the figures referred to represent specimens, all of them smaller than that in our fig. 9, of a star about 2 weeks old raised in the car):

> The young star-fishes figured on this plate (pl. VIII) were all found attached to roots of Laminaria, thrown up on the beaches, in the neighborhood, after a storm; and from their different stages of growth, as compared with the oldest star-fish raised from a Brachiolaria (pl. VI, fig. 11), specimens of which were also found upon these roots, it is probable that the sizes here figured are 1 (fig. 1), 2 (fig. 8), and 3 (fig. 10) years old. A considerable number of specimens were picked up in this way, and they could all be arranged into very distinct groups, representing the star-fishes of the present and of two previous seasons. There seemed to be no gradation from one group to another, such as we have among the young sea-urchins, which, in consequence of their manner of breeding during the whole year, form series the relations of which it is impossible to determine. In this connection I would say that by arranging the star-fishes found upon our rocks into series according to their size we are able to obtain a rough estimate of the number of years required by them to attain their full development; this I presume to be somewhere about fourteen years.† They begin to spawn

* Eggs from a specimen of 38 mm. were readily fertilized with spermatozoa from a male of same size.

† For an account of the method adopted by Professor Agassiz for ascertaining the age of many of our marine animals, see Proceed. Essex Inst., 1863, p. 252.

before that time, as specimens have been successfully fecundated which evidently were not more than six or seven years old. It is during the fourth year that the rate of growth seems to be most rapid. A young star-fish, measuring 1½ inches across the arms, was kept during five months alive in Mr. Glen's tank at the museum, and during that space of time it grew to 3 inches.

It will readily be seen that my observations do not agree with those of Agassiz. I found no difficulty in obtaining all possible gradations in size among the stars in the late summer, and those represented by Agassiz as 1, 2, and 3 years old, respectively, more nearly correspond with those raised in cars when they were 1, 2, and 3 weeks old.

XII. *What are the natural enemies of the star-fish?*

The destructive agents and natural enemies referred to in the last report were cold and fresh water, various fishes which feed upon the larvæ, gulls and crows, and parasites. Some specimens which were attacked by the parasite frequently found in the fall of 1897 were kept over winter, and by spring the disease had disappeared; but the effects of the disease were sometimes visible. In one case an arm was entirely eaten through, about ¾ inch from the tip, but was not thrown off. The stump healed over, and the star was kept throughout the year. It showed almost no trace of regeneration, probably because food was rarely taken by the specimen.

The enemy which is doubtless the most destructive to the star-fish is the menhaden. In an article on the "Food of the menhaden," published in the United States Fish Commission Bulletin for 1893, Dr. James I. Peck showed that this fish feeds exclusively upon the minute organisms which swim or float free in the water. The open mouth of the menhaden has an area of about a square inch, and as the fish swims through the water with open mouth and gill-covers raised, a considerable column of water is passed through the mouth every minute (estimated by Dr. Peck at about 7 gallons). The gillrakers strain the water, and the organisms which are not too minute are caught in the mouth and swallowed. The star fish larvæ, of even small sizes, are far too large to pass through the gillrakers. Numerous schools of menhaden feed in our bay during the season when the star-fish larvæ are swimming at the surface, and undoubtedly destroy them by thousands of millions.

After the stars are set they are no longer in danger of being destroyed by the menhaden, but for several weeks are bright conspicuous objects upon the seaweed and eelgrass for eels and many small fishes to feed upon.

XIV. *Is the popular idea that the dismembered fragments of a star-fish will regenerate new star-fish founded on fact?*

This idea is commonly held, and is apparently founded on the fact that in nearly every lot of stars brought up in the dredges or on the mops a considerable number may be found which are regenerating lost parts. Frequently two, three, or even four arms are being regenerated, and these are much smaller than the original arms. Upon careful examination and inquiry into the extent of this regeneration I have never found a well-authenticated case among our species of stars in which part of the disk was being regenerated, except those reared with great care in the aquarium. With this point in view I have examined a large number of regenerating stars caught in their natural haunts, some of them reported to be regenerating part of the disk, but invariably the regeneration was limited to the arm. I have, however, made a few experiments in the aquarium and in the cars which have a bearing upon this question.

The fact that a mutilated arm is frequently loosened and dropped off at a particular point near the base and the rate of regeneration of specimens which have thus lost one or two arms are recorded previously (p. 219).

All of the arms may be pulled off and if the star is protected and fed all will regenerate. Such a specimen is sketched in fig. 25. This specimen was kept after the operation in a glass dish with frequent changes of water, and was fed upon the soft parts of crabs, etc. The regeneration was slow as compared with that given in the previous tables, the new growth shown in the figure (which is natural size) requiring five or six weeks, probably owing to the comparatively small amount of food taken.

Since a mutilated arm drops off from the disk so readily, the latter nearly always remains intact, and in ordinary cases, therefore, if two stars were to result from one, one of them must regenerate from a single arm. I have several times kept single arms for a long time in the aquarium or cars, but have never seen any trace of regeneration in them. On May 11 several arms were taken off at the usual line of detachment, and kept alive in the aquarium until June 9, when they showed no sign of regeneration. One of these was still alive on June 25, and at that time was apparently enjoying good health, and would turn over if put on its back. It had lived, therefore, for over six weeks, but showed no signs of regeneration.

Another experiment was started on August 15; two arms were taken off from each of four specimens. The rate of regeneration of these specimens is given in the tables on p. 219. On September 10, nearly three weeks afterwards, five of the single arms were found alive, but showed no regeneration. On September 5 the new growth in the arms regenerating from the disk was from 8 to 5 mm. On September 26, six weeks after the operation, one of the single arms was found alive (7 mm.) It had not shown any traces of regenerating a new arm, although it had healed. This arm is represented natural size in fig. 24, *b*, and the new growth which took place on one of the stars from which these arms were detached is shown in fig. 24, *a*. Similar experiments were tried last year with the same result. In a recent article by Miss Helen Dean King, in Roux's Archiv, it is stated that single arms were kept alive for two weeks, but never showed signs of regeneration.*

Several experiments were carried on to determine what regeneration would take place if the disk were cut through. On the 11th of May 19 specimens about 2½ inches in length were treated in the following manner: Two arms were pulled off, and at the base of one of the arms a piece was cut out from the top of the disk in the manner shown in fig. 26. These specimens were placed in a large car at Woods Hole without food (except what could be carried in the water). On June 9 there was a trace of regeneration in some of the arms. On June 25, a little more than six weeks after the operation, all the arms were growing out anew, and varied from a mere trace of a new arm with the terminal eye-spot (which always shows first) to arms ¼ inch (about 7 mm.) long. This experiment shows two things: that the new arm will regenerate if a portion of the disk is absent, and that the rate of regeneration, like the rate of growth, in normal specimens, is dependent upon the nourishment, for while the new growth in these cars was only 7 mm. in six weeks, those which were well fed at Kickemuit gained a new growth of from 13 to 18 mm. in the same time. See page 217.

Other experiments were tried, to determine what regeneration would take place if the whole star-fish were cut through in various ways, while the arms were left in place. It will be seen that the results were not always the same.

In the summer of 1897 several stars about 2½ inches in length were cut through so as to leave three arms and part of the disk on one piece and two arms and part

*During the summer of 1899 several single arms were kept alive from early in May until the middle of August, when they were destroyed by accident. There was no regeneration.

of the disk on the other. The smaller pieces perished, but the larger ones lived for several weeks and showed no sign of regeneration. All but one were destroyed by other star-fishes which got into their compartment of the car by accident. The remaining fragment, consisting of three arms and part of the disk, lived several months after the operation and did not regenerate.

On May 11, 1898, several stars about an inch long were cut as in fig. 27. One arm was pulled off and the disk then cut in two, leaving two arms with a part of disk and madreporic plate on one piece (= *a*), and two arms and part of disk on the other piece (= *b*). The fate of the single arm has been already considered (page 222). On June 9 all the pieces were alive. In the piece marked *a* (i. e., having madreporic plate) a trace of a new arm was visible on the side toward the lost arm, but in no other place. The pieces marked *b* showed no regeneration at all.

On June 25, 6½ weeks after the operation, the condition was as follows: All these parts of specimen 1 were alive. The fate of the single arm has been mentioned previously. The piece (*a*) with madreporic plate is sketched from the lower side in fig. 28. Two arms were well started and one minute arm was growing out between them. In the other piece (*b*) of this specimen, the wound was completely healed, but there was no visible trace of any new arms. Of specimen 2, only one piece (*a*) was alive. From the stump of the old arm a very small new arm appeared—no trace of any other. The two pieces *a* and *b* of specimen 3 were alive and healthy. In *a* two very small arms were visible (one could be seen only with the help of a hand lens) near together, and on one side of the cut surface; on the other side there was a trace of another arm, indicated by an eye-spot. *b* had healed up, but showed no trace of regenerating arms. Of the fourth specimen, piece *a* was alive with two very minute regenerating arms. These specimens had very little food, and it is hardly necessary to remark that they grew very little or not at all.

On September 5, 1898, another experiment, similar to the last, was commenced at Kickemuit River. Eight specimens were taken from those reared in the car and cut in two in the manner shown in fig. 29, leaving two arms and the madreporic plate on one piece and three arms and part of the plate on the other. The pieces of the latter sort died in a short time, and the following data refer to the pieces having two arms and the plate ("eye"). At the beginning of the experiment the specimens measured in millimeters, 23, 21, 21, 20, 19, 18, 18, 18.

September 26, 3 weeks after the operation:
- A, 22 mm., bore trace of two new arms.
- B, 18 mm., two new arms (preserved) unhealthy.
- C, 18 mm., one new arm, 2 mm.
- D, crushed.
- E, 20 mm., healthy; no trace of another arm.
- F, overlooked. See next, Oct. 12.

October 12:
- A (?), 23 mm., two very small arms.
- C, 20 mm., two arms, one smaller than the other.
- E (?), 22 mm., no trace of regeneration.
- F, 21 mm., one arm.

(all healthy.)

October 25:
- C, 20 (?), two arms 8 to 10 mm.; no trace of other.
- E, 22, no trace of regeneration.
- F, $\left\{\begin{matrix}21\\20\end{matrix}\right.$ (?), one arm, 6 mm.; no trace of another.

November 5:
- A, 25 mm., two new arms, 2 mm. each.
- C, 21 mm., two new arms, 9 to 10 mm.; no trace of other.
- E, 22 mm., one new arm directly in middle, 1 mm. long.
- F, 19 (?), one arm, 4½ mm.; no trace of rest.

November 11 (fig. 30):
- A, 23 mm., two small arms, about 3 mm.
- C, 21 mm., two small arms, 10 and 12.
- E, 21 mm., one arm, 1½ mm., directly in middle.
- F, 20 mm., one arm, 6 mm.

(no trace of other arms in any.)

Similar experiments upon young stars about the first of August yielded essentially the same results, except that out of seven pieces which lived until September 5 four were without madreporic plate and three of these were regenerating new arms. Miss King, whose recent article has been already referred to, seems to have had better success than I, and says that from each of the pieces of a star cut in two a new star may

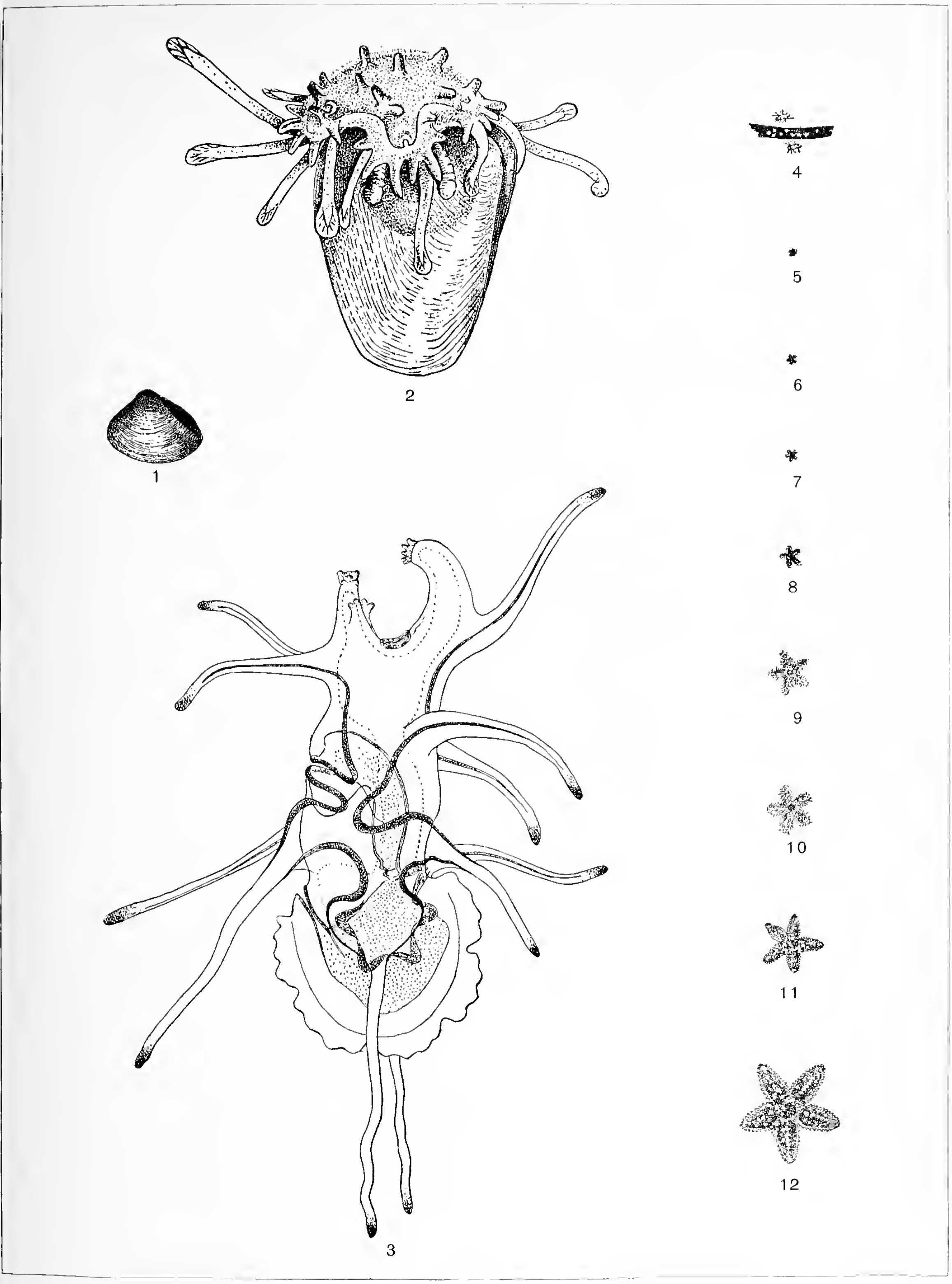
be formed by regeneration. That the madreporic plate is not essential to the life of the star, at least for a very long time, is shown by another experiment: This organ was removed from five large stars on June 14, and on November 5 one of them was alive and healthy, but had not regenerated the lost structure. The madreporic plate was wanting in a specimen caught at Woods Hole on April 4. Another was taken which had an accessory madreporic plate, which was not, however, connected with the stone canal. In the last report I mentioned an experiment in which this body was extirpated and regenerated before the end of the season.

In every known case of regenerating star-fish caught on the mops and dredges the new growth is limited to the arms. The arms are readily loosened and cast off when injured, but almost certainly do not produce new stars, as is shown by the experiment in which single arms have been kept three months without trace of regenerating, and by the fact that single arms regenerating the rest of the stars have never been found among this species of star (they are common in some foreign species). Star-fish which have been cut in two behave differently in different cases. They may live for a long time without regenerating the remaining arms to the slightest degree; they may show no sign of regeneration for several weeks and then regenerate one or more arms; they may soon regenerate only one or two of the arms when three are required to complete the original form of the body. The rate of regeneration and perhaps the possibility of regeneration are, like the rate of growth, dependent on the food supply. It is probably possible for two or more complete stars to result from one, but in many experiments in which the stars were carefully protected this result has not been obtained by me. The probability of this result occurring when stars are torn apart and thrown overboard is doubtless very slight, for, as the experiments show, such stars have difficulty in obtaining food and are especially liable to injury and to destruction by other stars or enemies of various kinds.

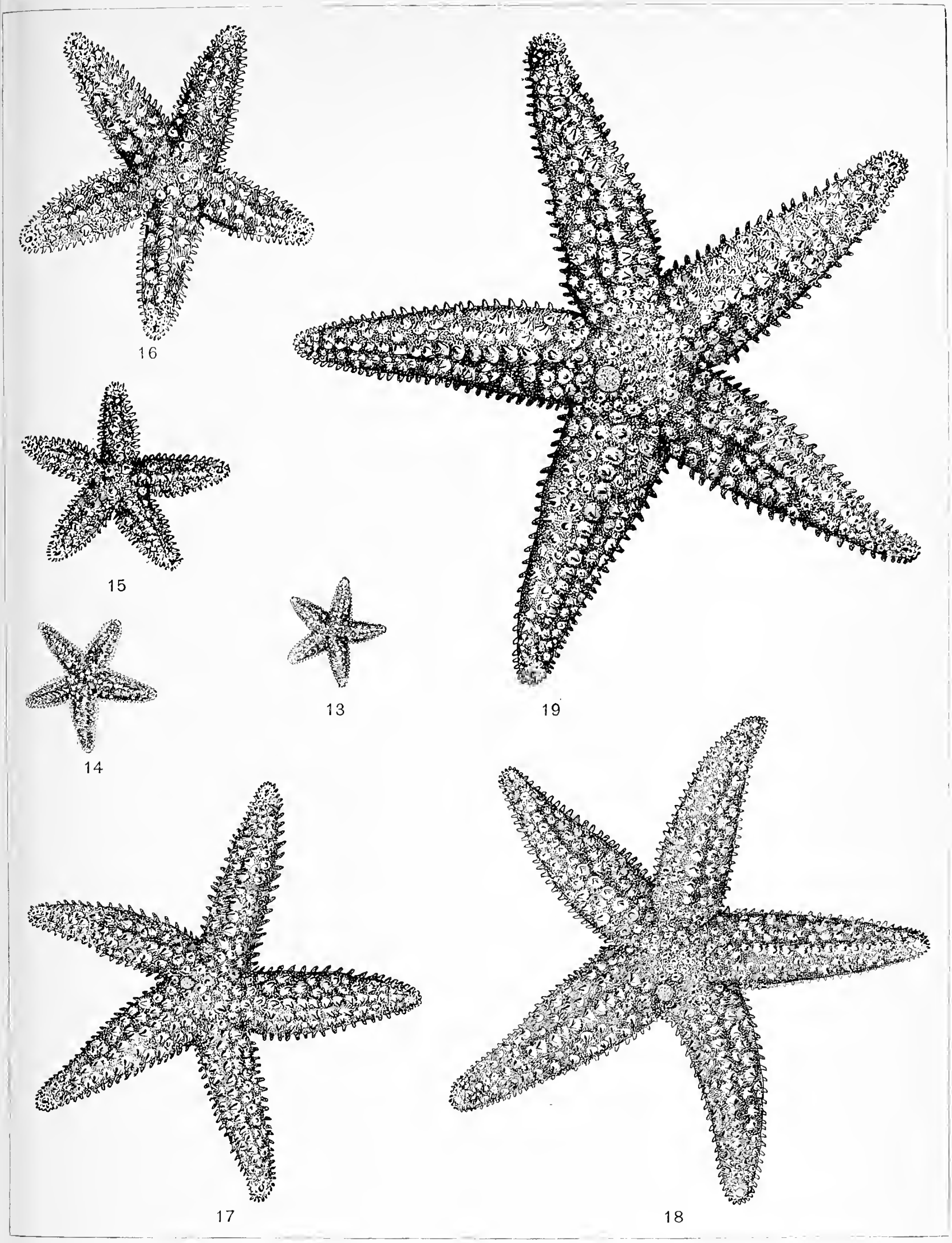
XV. *What are the artificial methods of destruction now in use in Rhode Island or elsewhere?*

Star-fishes are caught in considerable numbers with the spear and tongs, but the more efficient method is the use of the "tangle" or "mop." The tangle consists of a number of mops of cotton waste or similar material attached to an iron bar. By dragging these mops over the oyster-beds the stars become entangled and are drawn up with the mops. The mops are usually detached from the iron bar and are thrown, together with the stars, into a tub of hot water. Meanwhile other mops are attached to the bar and thrown overboard. After the stars are killed they can be more easily picked off the mops than when they are alive. Some oystermen prefer to dredge up oysters, stars and all, and, after having culled out the stars, to replant the oysters.

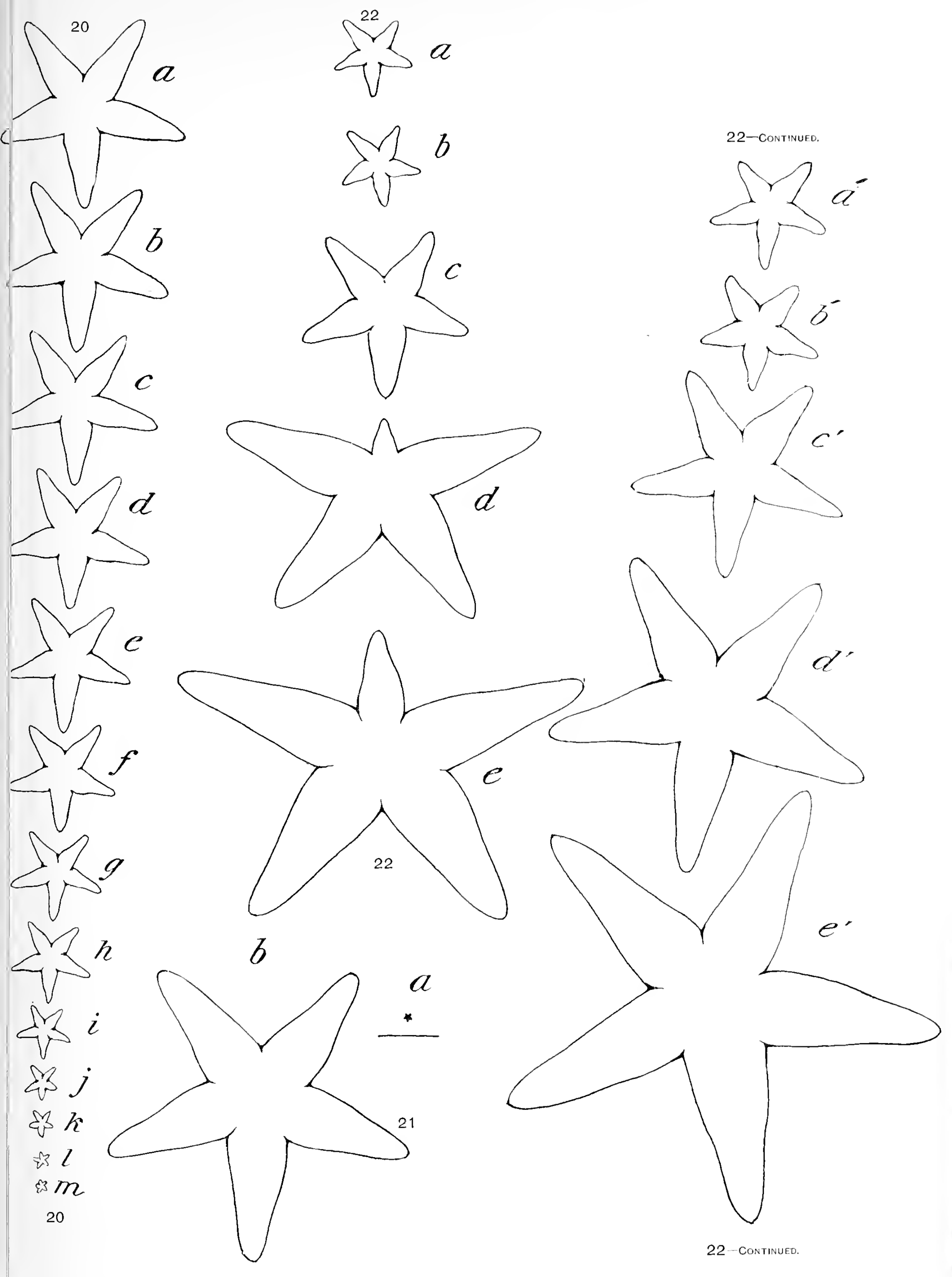
The star-fish become easily entangled in the mops, not only because they are rigid and covered with spines, but because the little forceps (pedicellaria) thickly scattered over the surface of the body catch hold of the threads of the mop. If one presses the upper surface of a live star-fish against the back of his hand he will find that these pedicellaria grasp the hairs on the hand tightly and will sustain the whole weight of the star-fish.



1. *Mulinia lateralis*, gray. Natural size.
2. Star-fish about 2 days old, much enlarged, devouring a clam. Outlines of stomach of star-fish can be seen through transparent shell of clam. (Drawn from life by Dr. J. L. Kellogg.)
3. Larva of star-fish, nearly ready to set, in side view; dark bands show position of vibratile cilia; intestine and stomach shaded; five lobes at lower portion of figure are beginning of the five arms. Larvæ of about the same age are shown in figure 4. (From life; much magnified.)
4. Piece of eelgrass with star-fish larvæ just undergoing their transformation; two larvæ at sides. Natural size.
5 to 8. Small specimens of star-fish from seaweed, about the first of July. Natural size.
9. Shows size of average star found upon eelgrass and seaweed, on July 15. Natural size.
10. Large specimen from car, July 15. Natural size, 3 mm.
11. From car, July 18, large specimen, 5 mm. Natural size.
12. From car, July 24, large specimen, 8 mm. Natural size.

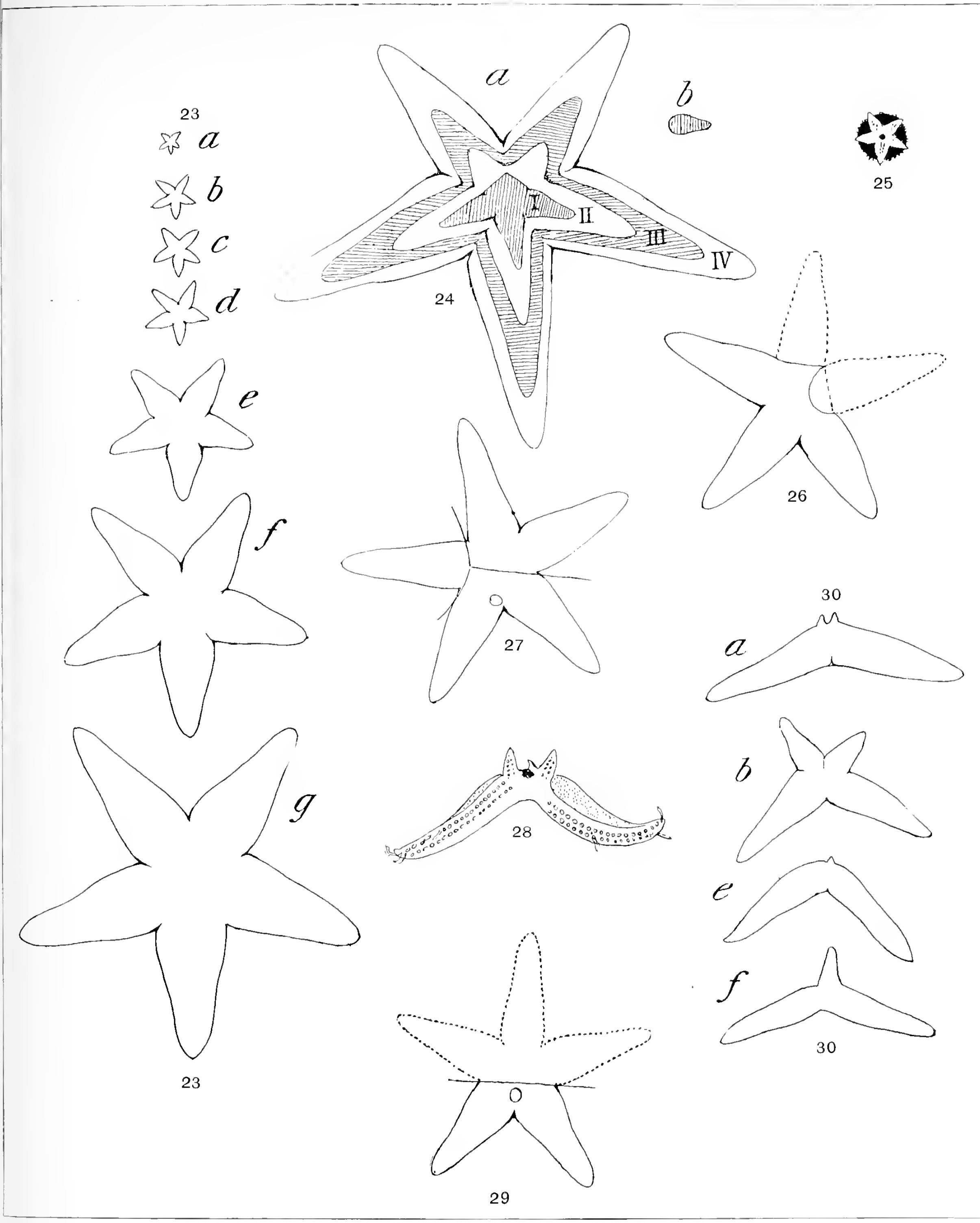


13. From car, July 26, large specimen, 9 mm. Natural size.
14. From car, August 2, large specimen, 11 mm. Natural size.
15. From car, August 18, large specimen, 18 mm. Natural size.
16. From car, September 5, large specimen, 24 mm. Natural size.
17. From car, September 26, large specimen, 35 mm. Natural size.
18. From car, October 12, large specimen, 42 mm. Natural size.
19. From car, October 25, largest specimen, 54 mm. Natural size.



20. Series of star-fish taken on August 18, showing variation in size; first 4 specimens from eelgrass, last 9 from car. Natural size.
21. *a*, Star-fish set June 28; kept alive in dish, and drawn natural size, September 6 ($5\frac{1}{2}$ weeks); *b*, from car, September 5, within a day or two of the age of *a* (p. 218). Natural size.

22. Shows rate of growth in two stars, *a*, *b*, etc., and *a′*, *b′*, etc.; *a* and *a′*, August 3, 7 and $10\frac{1}{2}$ mm.; *b* and *b′*, August 16, 7 and $10\frac{1}{2}$ mm.; *c* and *c′*, September 5, 15 and 19 mm. (one arm pulled off from *c*); *d* and *d′*, September 26, 28 mm. (new arm 10 mm.) and 29 mm.; *e* and *e′*, October 12; *e*, 36 mm. (new arm 20 mm.); *e′*, 40 mm. Natural size. See page 219.



23. Shows growth of single specimen collected as a larva and set June 28. *a*, July 23, 2 mm.; *b*, August 13, 4 mm.; *c*, August 18, 4½ mm.; *d*, September 5, 5 mm.; *e*, September 26, 12 mm.; *f*, October 12, 21 mm.; *g*, November 5, 30 mm. Natural size. See page 218.

24. *a*, Rate of growth and of regeneration: I, August 15; II, September 5; III, September 26; IV, October 12; *b*, single arm alive, from August 15 to September 26. Natural size. See page 219.

25. Star regenerating five arms from ventral side. Natural size. See page 222.

26. Showing manner of cutting the stars in the experiment described on page 222.

27. Showing manner of cutting the stars in the experiment described on page 223.

28. Showing the regeneration of the arms in the experiment described on page 223; a portion of the disk regenerating three arms. Natural size.

29. Showing manner of cutting the stars in the experiment described on page 223. Natural size.

30. The result of one of the regeneration experiments described on page 223; one or two arms regenerating from a part of the disk. Natural size.

Contributions from the Biological Laboratory of the U. S. Fish Commission, Woods Hole Massachusetts.

ON THE MOVEMENTS OF CERTAIN LOBSTERS LIBERATED AT WOODS HOLE DURING THE SUMMER OF 1898.

By HERMON C. BUMPUS,
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For several years, during the spring and early summer, a large number of egg-bearing lobsters have been collected from the shores of Connecticut, Rhode Island, and southern Massachusetts and brought to the hatchery at Woods Hole, where the eggs have been removed and the "stripped" animals returned to the ocean, either at Woods Hole or, in special cases, near the place of capture. The lobsters were of good size, generally exceeding 10½ inches in length, although some were smaller, especially those from the shores of Rhode Island, where the marketable length is only 9½ inches.

It occurred to the writer that data respecting the movements and habits of female lobsters at the close of the breeding season might be secured if the animals should be tagged before liberation, and accordingly copper tags, bearing consecutive numbers and the request that they be returned to the Commission, were attached to the rostrums of about 500 specimens, and these animals were liberated during June and July, 1898. On the 17th of June 34 lobsters, numbered 582 to 615 inclusive, were "stripped," tagged, and liberated in Vineyard Sound, near Lackey Bay. Six of these were subsequently captured by lobster fishermen and the tags were returned to the Commission.

This group of lobsters yielded data as follows:

No.	Liberated.		Recaptured.		No. of days free.	Distance (miles).	Direction.
	Locality.	Date.	Locality.	Date.			
594	Lackey Bay	June 17	Menemsha	(?)	(?)	9	SSW.
595	....do	....do	Vineyard Sound	July 11	24	0	0
604	....do	....do	....do	June 17	1	0	0
606	....do	....do	....do	July 5	18	0	0
609	....do	....do	....do	July 11	24	0	0
611	....do	....do	Menemsha	(?)	(?)	9	SSW.

The four recaptured near the place of liberation were taken by Mr. Alfred Nickerson, whose traps are near the southerly opening of Woods Hole, extending from Nobsque to Lackey Bay. The distance traveled by these lobsters can, therefore, only be estimated, although the most remote traps were probably not more than a mile or two from the point of liberation. One was captured on the day of its liberation. Mr. Hillman, whose traps were located near Gayhead, returned tags 594 and 611 to the Commission, but unfortunately he did not return dates with his tags, so that

the rate of travel of these and other lobsters taken by him can not be given. It will be noted that the general course of the lobsters is toward the south and west.

On the 18th of June 94 lobsters were tagged and placed on the steamer that runs from Woods Hole to New Bedford. The writer deposited 33 of these in Buzzards Bay, near the westerly opening of Woods Hole; 17 when the steamer was about midway between Woods Hole and New Bedford; 33 at a point south of West Island, and 11 as the steamer passed Black Rock. For convenience these stations have been named A, B, C, and D, respectively, and are so indicated on the chart at the end of this paper. Along this course of the steamer there is an almost continuous series of lobster pots extending entirely across the bay, many of them owned by Greeks and Portuguese, who are somewhat disinclined to return the tags, preferring to keep them as charms. It is perfectly safe, therefore, to conclude that only a small proportion of the tags taken are finally returned to the Commission.

From station A, 4 tags were recovered; from station B, none; from station C, 4, and from station D, 2. The details are as follows:

No.	Liberated.		Recaptured.		No. of days free.	Distance (miles).	Direction.
	Locality.	Date.	Locality.	Date.			
618	Station A	June 18	Near Hen and Chickens	July 15	27	16	WSW.
628	do	do	Cuttyhunk	July 30	42	12	WSW.
629	do	do	Near West Island	July 9	21	4	WNW.
645	do	do	do	July 2	14	4	WNW.
650	Station C	do	Cuttyhunk	July 1	13	9	SW.
654	do	do	Near Station A	June 29	11	4	E.
667	do	do	Penikese	July 7	19	6	SW.
681	do	do	Near Station C	June 30	12	0	0
699	Station D	do	Near Station D	July 9	21	0	0
705	do	do	do	June 30	12	0	0

None of the lobsters distributed on June 18 took a northerly course, and although three were taken at points roughly described as east of their place of liberation, four traveled toward the mouth of the bay, all of them considerable distances, and No. 618 made a journey of 16 miles between June 18 and July 15, twenty-seven days. This is the longest distance traveled by any of the lobsters. Those liberated at stations B, C, and D were taken originally at Cuttyhunk. The fact that two of these, Nos. 650 and 667, returned to their former place of capture may indicate a strong homing instinct.

On the 24th of June 62 lobsters, originally from Noank, Stonington, and Block Island, were liberated at Quicks Hole at a point indicated on the chart. The tags of eight of these were returned to the Commission. The details are as follows:

No.	Liberated.		Recaptured.		No. of days free.	Distance (miles).	Direction.
	Locality.	Date.	Locality.	Date.			
711	Quicks Hole	June 24	Quicks Hole	July 5	11	0	0
714	do	do	do	June 28	4	0	0
715	do	do	Menemsha	(?)	(?)	5	SSE.
730	do	do	Robinsons Hole	June 30	6	2	E.
743	do	do	Quicks Hole	July 8	14		
747	do	do	Menemsha	(?)	(?)	5	SE.
756	do	do	Cuttyhunk	July 19	25	6	WSW.
759	do	do	Robinsons Hole	July 5	11	2	E.

Of the animals liberated on June 24, it might be said that their course was not so characteristically toward the south as were the courses taken from some of the other stations, but the three which had traveled a sufficient distance from the point of liberation to give a distinct trend to their course did move in the same direction as

those of other stations. As the lobster pots are not set in large numbers off shore, lobsters liberated at Quicks Hole naturally would not stand the same chance of recapture toward the south and west that they would toward the north and east, and therefore it would seem to be of more than passing interest that from this southern point of distribution no lobsters were found to migrate to any considerable distance either up the sound toward Woods Hole or across the bay toward New Bedford.

A second lot, of 140 lobsters, was liberated off Nobsque on the same day as those liberated at Quicks Hole. These were quite at liberty to migrate in a northeasterly direction, but all reports of their capture came from the southwest. That so many of these and other lobsters took a southwesterly course would seem to prove that there is in general a decidedly southerly and westerly trend to their migrations, although I am not prepared to say whether this is in response to a strong homing impulse, or an effort to pass from warmer into colder water, or from shallow into deeper water. The proportion of animals captured to those liberated is noteworthy. Of 140 liberated at Nobsque, tags were received from 29. The details are as follows:

No.	Liberated.		Recaptured.		No. of days free.	Distance (miles).	Direction.
	Locality.	Date.	Locality.	Date.			
779	Nobsque	June 24	Woods Holo	July 11	17	0	0
789	do	do	Nobsque	July 5	11	0	0
791	do	do	do	July 11	17	0	0
798	do	do	Cedar Tree Neck	Sept. 21	89	5	SSW.
800	do	do	Woods Hole	July 11	17	0	0
802	do	do	Tarpaulin Cove	July 8	14	5	WSW.
807	do	do	Vineyard Sound	Aug. 11	48	2	SE.
819	do	do	Woods Hole	Aug. 28	65	0	0
821	do	do	Tarpaulin Cove	July 18–23	26	4	W SW.
825	do	do	Menemsha	?	?	11	SSW.
828	do	do	Nobsque	July 11	17	0	0
830	do	do	Tarpaulin Cove	July 18–23	26	4	WSW.
831	do	do	Vineyard Sound	do	26	4	WSW.
834	do	do	Menemsha	?	?	10	SSW.
838	do	do	Neshewena	July 8	14	12	WSW.
848	do	do	Gay Head	Aug. 15	52	13	SW.
851	do	do	Vineyard Haven	July 5	11	4	SE.
868	do	do	Quicks Hole	do	11	11	WSW.
869	do	do	Tarpaulin Cove	July 18–23	26	5	WSW.
872	do	do	Vineyard Haven	do	26	5	WSW.
879	do	do	Nobsquo	?	?	0	0
883	do	do	Robinson Hole	July 20	26	8	WSW.
889	do	do	Quicks Hole	July 23	29	9	WSW.
891	do	do	Nobsque	?	?	0	0
896	do	do	Vineyard Sound	?	?	6	WSW.
901	do	do	Menemsha	?	?	11	SSW.
902	do	do	Nobsque	July 11	17	0	0
904	do	do	Menemsha	?	?	9	SSW.
907	do	do	do	?	?	11	SSW.

On the 25th of June 58 lobsters were liberated near the can buoy at the entrance of Woods Hole Harbor. Of these, only three were recaptured. No. 928 remained in the neighborhood until September 15, when it was captured near the Wepeckets. The capture of this and other specimens would go to show that molting does not always take place immediately after the eggs have reached maturity, for, if the animals had molted, the tags would have been lost.

No.	Liberated.		Recaptured.		No. of days free.	Distance (miles).	Direction.
	Locality.	Date.	Locality.	Date.			
928	Can buoy	June 25	Wepeckets	Sept. 15	82	3	WNW.
945	do	do	Woods Hole	July 23	28	0	0
960	do	do	Quicks Hole	do	28	9	WSW.

On July 2 two lots of lobsters were liberated, 60 at Lackey Bay and 49 at Woods Hole. Of the former, 5 were recaptured, as follows:

No.	Liberated.		Recaptured.		No. of days free.	Distance (miles).	Direction.
	Locality.	Date.	Locality.	Date.			
980	Lackey Bay.	July 2	Vineyard Sound	July 11	9	0	0
999	.....do	....do	.....do	July 20	18	0	0
1020	.....do	....do	Quicks Hole	July 23	21	6	WSW.
1034	.....do	....do	Wepeckets	July 7	5	2	NW.
1098	.....do	....do	Robinson Hole	July 20	18	8	WSW.

It will be noted from the above that the trend of migration of all those that had traveled a considerable distance after liberation was in the same general direction as that taken by those liberated from the stations mentioned.

The lobsters in the second lot liberated on July 2 were thrown into the water near the Fish Commission station, and not only is the direction of their course interesting, but the rate of movement of certain individuals is far beyond one's expectation. The animals traveled down the bay in a west southwesterly direction at a rate that seemed to indicate their desire to place as much distance as possible between themselves and the hatchery. No. 1000 made the journey from Woods Hole to Cuttyhunk in 3 days, No. 1022 reached the neighborhood of the Hen and Chickens lightship in 6 days, and No. 1014 reached an equally remote point in 7 days. The following table will give additional data relative to the movements of this last series:

No.	Liberated.		Recaptured.		No. of days free.	Distance (miles).	Direction.
	Locality.	Date.	Locality.	Date.			
970	F. C. Station	July 2	Cuttyhunk	July 16	14	14	WSW.
971	.....do	....do	.....do	July 13	11	14	WSW.
977	.....do	....do	.....do	July 16	14	15	WSW.
991	.....do	....do	Woods Hole	July 7	5	0	....
1000	.....do	....do	Cuttyhunk	July 5	3	12	WSW.
1006	.....do	....do	Wepeckets	Sept. 15	75	3	WSW.
1009	.....do	....do	Woods Hole	July 11	9	0	....
1010	.....do	....do	Cuttyhunk	July 13	11	12	WSW.
1013	.....do	....do	Woods Hole	July 7	5	0	....
1014	.....do	....do	Hen and Chickens	July 9	7	15	WSW.
1019	.....do	....do	Wepeckets	Sept. 15	75	3	W.
1022	.....do	....do	Hen and Chickens	July 8	6	15	WSW.
1030	.....do	....do	Wepeckets	Sept. 15	75	4	WSW.
1054	.....do	....do	.....do	....do	75	3	W.
1055	.....do	....do	Penikese	July 26	24	11	WSW.

Attention has already been called to the strong migratory impulse which controlled the movements of the animals set at liberty, and it must be left for subsequent observations to determine the reason therefor. During the latter part of June and the early part of July the water near Woods Hole ranges in temperature from 62° to 69° F., and as the water in this portion of the bay and sound is received from the presumably cooler water of the southwest, the inclination of the liberated animals to seek cooler water may account for the uniformity in their movements. But lobsters are caught about the station during the entire summer, and the uniformly small size of these animals would indicate that they remain in the locality during the season and are not caught as they pass through the sound on their migrations.

It has been already suggested that the uniformity in the movements of the tagged lobsters may be the result of a homing instinct. This question might be answered in

the following way: If lobsters caught at Woods Hole and released at Gay Head were recaptured at Woods Hole, and if lobsters taken at the same time at Gay Head and released at Woods Hole were recaptured at Gay Head, it would seem that only a homing instinct could account for the movement.

It is quite possible that during June and July lobsters seek deeper water, although it is generally believed that during the spring and early summer the general migration is from deeper to more shallow water, and that the return to the deeper water does not occur until fall. During the summer months lobsters are caught off the coast of Maine in shallow water, ranging from 3 to 10 fathoms in depth, and it is not until October and November that the pots are set in deeper water, from 35 to 40 fathoms. Professor Herrick states that the fishermen generally take their traps from the deeper water and place them in the shallow water of the sound at about the time that we have found the animals seeking the deeper water. From the neighborhood of Gay Head the general migration into deeper water is said to begin the latter part of August and to continue during September and October. If a relatively large number of both sexes, and of different sizes, should be captured at Cuttyhunk or a place similarly located, and after being tagged should be returned to the place of their capture, valuable data of a positive nature would undoubtedly be secured. One wishes that this might be attempted.

It is possible that the movements are not dependent upon any of the above-mentioned factors, but that the supply of food is all-controlling. The peculiar behavior of female lobsters in the vicinity of No Mans Land, as observed by Mr. Vinal Edwards and recorded by Professor Herrick, would seem, however, to make this improbable.

In writing of the lobster's powers of movement, Professor Herrick says that by the flexion of its abdomen the animal is able to shoot backward through the water with astonishing rapidity, sometimes going, according to one observer, 25 feet in less than a second. He quotes Travis as follows:

> In the water they can run nimbly upon their legs or small claws, and, if alarmed, can spring tail forward to a surprising distance, as swift as a bird can fly. The fishermen see them pass about 30 feet, and by the swiftness of their motion suppose that they go much farther. Athenæus remarks this circumstance, and says that incurved lobsters will spring with the activity of dolphins.

While we do not know what method of progression lobster No. 1000 adopted in making her record of 12 miles in 3 days, we do know from the course taken by this animal, as well as by Nos. 1014 and 1022, that associated with their rapidity of movement there is remarkable endurance.

It is generally believed that the female lobster molts very soon after its young have escaped from the egg membranes, and although it is manifestly incorrect to consider a lobster artificially freed from its eggs as one which has completed the incubation period, the fact that many were recaptured with tags long after the period at which the young would probably have hatched under normal conditions, is a proof that in many cases females do not change their covering as soon as they are relieved of the obligations of maternity. One tag was taken as late as September 21.

One of the most interesting results from this series of experiments is the direct evidence of the merciless persecution of the lobster. The chances of continued life for a lobster that has reached a marketable size are extremely slight. Of the 140 liberated at Nobsque, more than 20 per cent are known to have been captured within three months, and 15 of the 49 liberated on July 2 at Woods Hole, or fully 30 per cent, were taken by September 15. Of course, these numbers do not begin to show

what actually occurs, for many fishermen are known not to have returned the tags; a large number of tags are doubtless lost by the process of molting, and not a few of the animals perish from rough treatment received during captivity. It should be remembered that when first captured they are thrown from the pot into the boat, and from the boat into a car, where they may remain several days awaiting the arrival of a smack to convey them to the station. While in the car they suffer from their own belligerency, and when thrown into the well of the smack and during their journey to Woods Hole not a few perish. Moreover, at the station they are handled several times before they are finally stripped, tagged, recorded, and made ready for their liberation.

Figure of tag—exact size.

But without attempting to make any estimate of the number that reached the market without leaving a completed record, and confining ourselves to the data derived from those that were recaptured, we find that of a total of 479 lobsters liberated, 76 very soon found their way to market. It is therefore evident that, unless the supply of any one locality is replenished, either by immigration or by artificial propagation, the lobster will be exterminated; indeed elimination has actually occurred at certain localities, and there is every indication that before long an industry which has yielded many millions of dollars will have perished through the inexcusable abuses of our fishing privileges.

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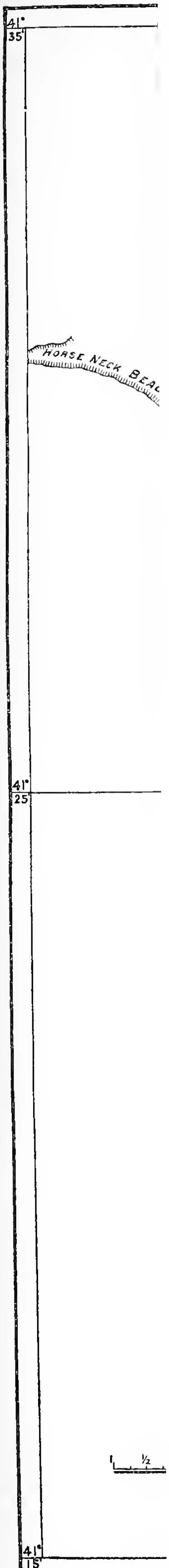
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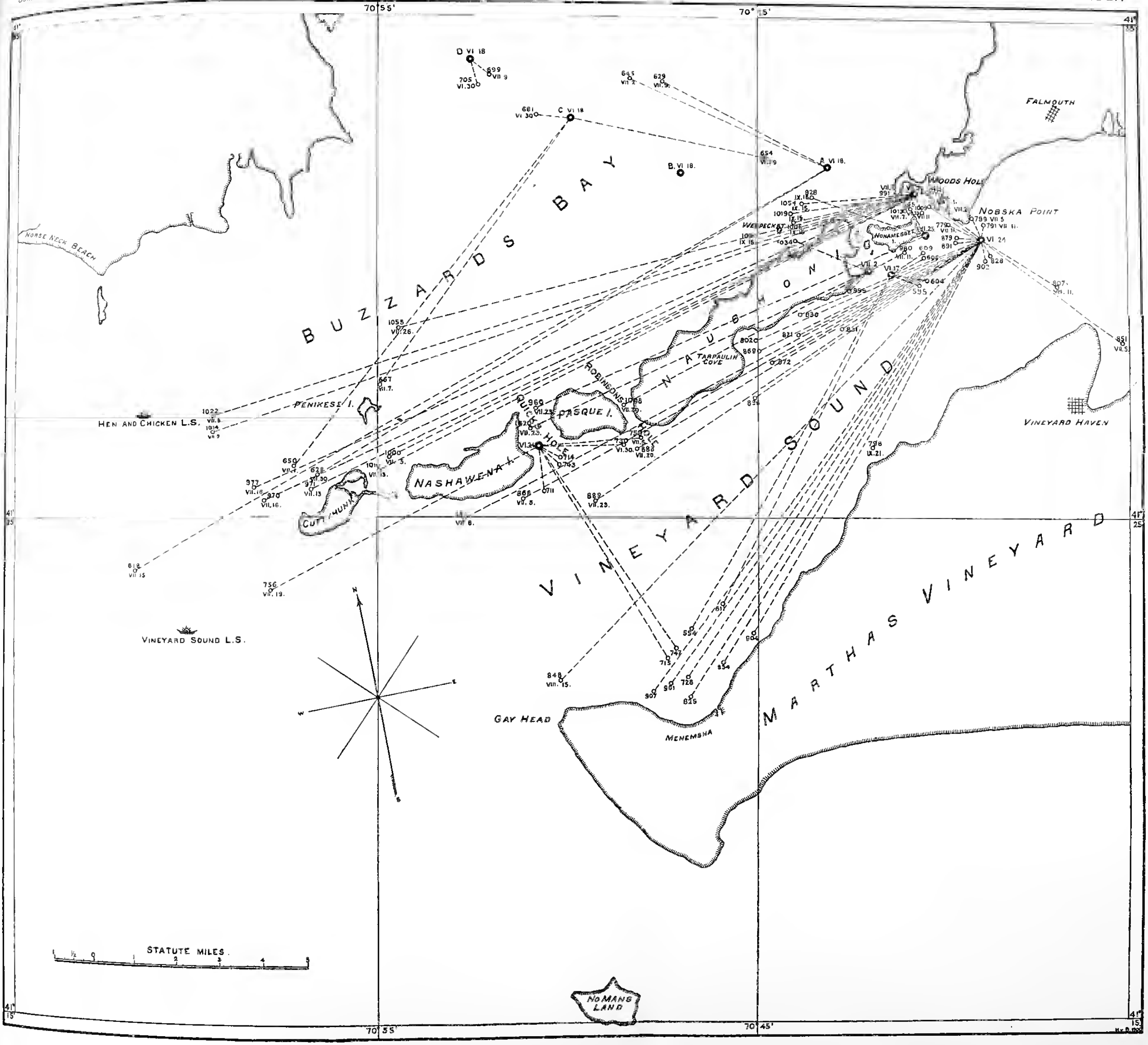


MAP OF THE REGION OF WOODS HOLE SHOWING MIGRATIONS OF LOBSTERS.

Contributions from the Biological Laboratory of the U. S. Fish Commission, Woods Hole, Massachusetts.

IMPROVEMENTS IN PREPARING FISH FOR SHIPMENT.

By RALPH W. TOWER,
Assistant Professor of Chemical Physiology, Brown University.

It is well known that ice, as ordinarily used in packing, is more or less unsatisfactory. It spoils the freshness, flavor, and firmness of the fish; but, moreover, the moisture of the melting iee favors the development of putrefactive bacteria and thus hastens decay, which is only the result of the activity of eertain putrcfaetive bacteria. If the fish arc so handled that the activity of the bacteria is restricted, the process of decay will be retarded; but if the fish are handled so as to eneourage the ravages of the baeteria, the process of decay will progress much more rapidly. The pressing of fish by close packing softens the muscles and renders the flesh more suseeptible to invasion by putrefactive bacteria. Paeking fish in foul barrels and unelean boxes, the eontamination from which is eonveyed to the fish by the melting ice, also contributes to their speedy dceay.

The following investigations, whieh were carried on at the biologieal laboratory of the United States Fish Commission at Woods Hole, werc undertaken for the purpose of aseertaining to what degree fish are spoiled by carelessness, filth, and bad paeking, and to devise methods which might mitigate these evils.

The animals used for the experiments were squeteague, bonito, blue-fish, and tile-fish. The fish from the large trap owned by the United States Fish Commission and located in Buzzards Bay furnished an unlimited supply of material. During July and August squeteague were abundant; their flesh is soft, very susceptible to invasion by putrefactive baeteria, and difficult to preserve by the ordinary methods of paeking. Bonito were also oeeasionally taken; their flesh is firm and hard and relalatively easy to prescrve.

The first experiments were to determine the influenee of ordinary summer temperatures and of the different methods of killing and handling upon putrefaetion; 48 squeteague were hung up by a wire passing through the eyes; 24 had the intestines removed, after which the fish were immediately drained; the other 24 were not opened. The experiment was made in a plaee protected from the sun, but to which the air had free acccss. The weather was humid and foggy, the temperature being 68° at 8 a. m., 72° at noon, and 71° at 5 p. m. After 24 hours the fish were examined. Those that had not been opened were putrid and emitted an almost unbearable odor. Those whose

intestines had been removed were in better condition, and might even have been used for food. The abdominal cavity was much fresher and putrefaction had not penetrated so deeply into the flesh. The experiment shows that when the intestines are not removed decomposition takes place more rapidly, and that the immediate removal of the viscera delays decomposition. The experiment gives some idea of the rates of putrefactive changes in the two kinds of fish.

The next experiment was with 24 squeteague and 6 bonitos. After removing the intestines, as above, the fish were laid on their sides on a plank, but not in contact with one another. The day was humid and foggy, the temperature ranging from 69° at 8 a. m., and 72° at 12 m., to 71° at 5 p. m. At the end of 24 hours the fish were examined. The squeteague were badly decomposed on the side next the wood; on the other side decomposition had not proceeded so far, although it had progressed to a considerable extent. In the body-cavity decomposition was evident, but it had not advanced very far. The bonitos were in much better condition, although they emitted an odor of putrefaction, the side on which they lay being most affected. The walls of the body-cavity also were in better condition than those of the squeteague. The experiment shows that the free circulation of air about fish retards the process of decay.

After the intestines had been removed from 12 squeteaque the fish were hung up by their tails and allowed to remain 24 hours. The weather was cloudy, and the temperatures were as follows: 8 a. m., 71°; 12 m., 74°; 5 p. m., 73°. The atmospheric conditions were less favorable than on the previous day, yet at the end of 24 hours the fish were found to be in much better condition than in any of the preceeding experiments. There was a decided odor of putrefaction from the outside of the fish, but the abdominal cavity and the muscles showed only slight evidences of decomposition. The fish were in as good condition as many fish found in our markets and generally sold as "fresh." The experiments thus far made show that early cleaning, free circulation of air, and thorough draining retard putrefaction.

Twenty-four living squeteague were decapitated, thoroughly drained, and then their intestines were removed. From another series of equal number the intestines only were removed. The 48 fish were packed in a box in close contact with one another. The weather and temperature conditions were practically the same as on the preceding day. At the end of 24 hours the fish were very soft and had a bad odor. Although the 24 which had been decapitated were in a better state of preservation than the others, all were unfit for use. Those in the top layer, where they were exposed to the air, were in early stages of decomposition. Those on the bottom, away from the air and moistened by the drip from those above, were in advanced stages of decomposition. The experiment indicates the importance of thorough drainage of the flesh by early decapitation. The presence of blood hastens decay.

In all the above experiments the fish were taken from the fish-trap alive, and were immediately prepared to meet the conditions of the various experiments. By this means no decomposition could have taken place before the experiments were begun. The fish were handled as carefully as practicable, to prevent bruising or rupture of the muscular tissue. Cleanliness was assured through copious washing with sea water.

To recapitulate, the experiments show:

(*a*) That putrefaction takes place more rapidly if the viscera are not removed.

(*b*) That moisture hastens the process of decay.

(*c*) That the free access of air retards putrefaction.

(*d*) That drainage of the blood retards putrefaction.

(*e*) That if the head and intestines are removed, and if the fish is suspended by the tail so that the blood is drained from the entire body, the fish will remain sweet for a considerable time without the use of ice.

In none of the above experiments were putrefactive bacteria *prevented from entering the flesh* or directly hindered in their action after entrance. Consequently, further investigations were made to determine the feasibility of delaying bacterial invasion. To do this the fish must be *washed* with a solution which retards the growth of bacteria and is not injurious to the food qualities of the flesh. Various solutions were tried, but only one with success. In all cases control experiments were made on fish taken at the same time and subject to the same conditions, the only difference being that the control fish were not treated with the sterilizing fluids.

(1) The first experiment was with a 0.1 per cent solution of salicylic acid in sea water. 24 squeteague, taken alive from the nets, were carefully dressed, washed with this solution, packed in a box, and allowed to remain for 24 hours. The temperature ranged from 73° to 76°. When examined the next morning there was a perceptible odor of putrefaction; the fish were soft and unfit for market. The control fish were not much worse. Similar experiments were subsequently made with the same solution, but none were successful.

(2) The next preparation experimented with was a 10 per cent solution of potassium nitrate. 18 squeteague, cleaned immediately after being taken from the nets, were decapitated and thoroughly washed with this solution, and packed close together in a box. During the next 24 hours the weather was foggy, and the temperature ranged from 73° to 74°, at the end of which time decomposition had advanced to such a stage that the fish were totally unfit for shipment. There was no appreciable difference between the fish subjected to the potassium nitrate and those of the control experiment. Six more trials were made with this solution, but always with the same result.

(3) A 5 per cent solution of formalin was next used, but, as might have been predicted, the fish did not keep, and they were as bad at the end of 24 hours as those of the control.

(4) The next and most successful experiment was made with a 3 per cent solution of boric acid (B_2O_3) in sea water. 24 squeteague were dressed immediately after being caught, some decapitated, and others packed without removal of the head and gills. All were merely washed in the above solution and then closely packed in a box. The weather was foggy and cloudy, the temperature ranging from 74° to 83°. When examined 24 hours later the fish were in good condition, without odor, and decomposition had evidently not begun; the flesh was hard and firm, the eyes clear, and in fact one of the fish was declared by a native fisherman to have been taken from the water that very morning, and he was not readily convinced that it had been kept without ice for 24 hours. One of the squeteague was baked and served on my own table, and was pronounced excellent. It is needless to say that the control fish were in advanced stages of putrefaction and wholly unsuitable for food.

In these experiments with boric acid the fish were in no sense "embalmed," injected, or even preserved. The walls of the abdominal cavity, after the removal of the viscera, were simply washed with a sponge that had been dipped in the solution. The success of the experiment is of course largely dependent upon (*a*) the immediate

removal of the viscera after the capture of the fish; (*b*) the careful handling of the fish, both before and after evisceration; (*c*) the thoroughness with which the walls of the abdomen are washed, and (*d*) the care with which the fish are packed. The use of boric acid will not prove satisfactory if fish are first thrown about, walked upon, carelessly eviscerated, washed in the sterilizing fluid, and then pitched into barrels. Those who prefer to abuse fish in this way will do well to stand by the older and more expensive methods—use ice, and complain of the market.

Mr. E. G. Blackford, one of the largest wholesale dealers in New York, has said:

> As an example of increased returns to the shippers from careful handling, I call attention to the fact that certain shipments of shad going to the New York market from North Carolina bring from 25 to 40 per cent more than other shad from the same locality. * * * What I wish to impress upon the shippers and fishermen is that for every dollar invested in labor and ice in packing the fish they will receive ten dollars in return.

Twenty more experiments were made with the same solution. Some of the animals were decapitated and others were not, but the swim bladders and kidneys were removed from all. If the gills were thoroughly washed in the solution it was found that even fish with the head attached kept as well as those which were decapitated. Nevertheless, in fish treated with boric acid putrefaction first appears in the gills. A bushel of squeteague prepared in this way was put on the deck of the U. S. Fish Commission schooner *Grampus* on the morning of August 12, 1898, and remained exposed to the sun throughout the day; the next morning, when cut up for bait, they showed no sign of decomposition. On another trip, 1,000 pounds of tile-fish were washed in the solution and then packed in ice, where they remained for two weeks; when unpacked they were in a perfectly fresh condition.

It is evident, then, that this solution retards the initial stages of putrefaction, even at the summer temperatures, and for a sufficient time for the fish to arrive at the market, where they may be iced and kept indefinitely. The solution of boric acid thus used is *not a preservative*, and it is not intended as such, but, like soap, it is an *agent of cleanliness.* As the fish are simply sponged over, the amount of the fluid that remains on a single fish is inconsiderable, and careful analysis fails to show more than the least trace in the flesh. Moreover, Chittenden and Gies have shown that boric acid given in doses, even up to 3 grams per day, has no effect upon proteid metabolism or on the nutrition of the body; that it is not cumulative, but is quickly eliminated from the system, and that it produces no renal complications. Its employment, therefore, as above recommended can have no injurious effect on the consumer.

In preventing the growth of the micro-organisms which cause putrefaction we also eliminate the cause of ptomaine formation. Though some of the ptomaines are exceedingly poisonous, this is not characteristic of all, and it can be safely stated that the greater number of those that have been isolated are of a nonpoisonous nature. The kind of ptomaine formed depends on the kind of micro-organism which produces it, the character of the material acted upon, and the circumstances in which putrefaction takes place. As the ptomaines are only transition products, representing mere temporary stages in the great process of decomposition by which the complex organic molecule is transformed into the simple inorganic state, it is evident that the kind of ptomaine present in putrid fish depends on the stage of putrefaction. Ptomaines formed when putrefaction takes place in free atmosphere will differ from those resulting from putrefaction where atmosphere is excluded. Almost any illness caused from infected food is spoken of as being due to "ptomaine poisoning," but in the majority

of cases the poisonous bacterial products are not basic, though their true chemical structure is not understood.

It is worthy of note in this connection that poisonous ptomaines do not begin to appear until about the seventh day of putrefaction, and that they finally disappear if putrefaction is allowed to go on for a considerable time. The toxicity of the ptomaines themselves is not affected by cooking, no matter how thorough this may be. It should also be noted that there are two distinct kinds of poisoning that may arise from the use of fish as food. The first is an intoxication caused by the devouring of meat which has become invaded by ptomaine-producing bacteria. The second is an intoxication brought about by fish not necessarily infected with bacteria, but in which the poisons are *leucomaines* produced by the tissues of the fish and their normal product.

The researches of Meisener, Rosenbach, G. Hauser, F. Jahn, J. von Toder, and others have shown that the blood and flesh of healthy animals are entirely free from bacteria. But the contents of the digestive organs are rich in schizomycetes. Popoff has shown that the digestive canal of a healthy new-born animal is, at the moment of birth, free from bacteria. These, however, subsequently obtain access, principally in the food, and the contents of the bowels become extremely rich in microbes.

If a slaughtered animal is left without being disemboweled, these bacteria will make their way from the alimentary tract through the capillary vessels of the intestinal villi into the arterioles, the alkaline contents of which (rich in albumen) are especially favorable to these acidly putrefactive bacteria, so that the entire carcass quickly begins to undergo decomposition. This early decay may be prevented by the immediate removal of the entire alimentary canal, from esophagus to rectum, and if this precaution is taken the flesh (as already shown) will for a time remain free from putrefactive bacteria. If putrefaction afterwards sets in, it is probably due to bacteria from external sources which have obtained access to the flesh.

The gradual penetration of bacteria by way of the blood vessels into the interior of the flesh has been studied by Trombetta and Gartner. Gartner found them in the external layers only of meat 3 days old, but at the end of 7 days they had penetrated 2 cm. below the surface. It is probable, however, that the flesh of fish is not so resistant to the penetration of bacteria. The sources of this bacterial infection can not be entirely removed, but they can be considerably reduced by cleanly procedure, as above recommended, and attempts may be made to restrict the increase of the microbes and thus arrest the process of decay. The most common remedy is cold, but experiment has shown that the temperature must be kept some degrees below freezing to obtain the best results. This method is used not only in the American and Australian abattoirs, but haddock caught in Norway are cleaned and frozen at —50° C. and then shipped in specially constructed steamers. This freezing of fish does not immediately kill the bacteria present, for Koch has found very many bacteria in fish treated in this way, but it prevents the reproduction of the bacteria for the time being.

Foster has found that certain germs increase in meat stored at moderately low temperatures, though actual putrefaction is not produced by them. Moreover, the researches of Frænkel, Bordoin, Uffreduzzi, Prudden, and Heyroth show us that natural ice may contain both putrefactive and pathogenic bacteria. This fact alone should teach us to look with suspicion upon any meat that has been brought in direct contact with ice of unknown origin, especially when the ice is allowed to melt so that the drip soaks into the flesh.

Contributions from the Biological Laboratory of the U. S. Fish Commission,
Woods Hole, Massachusetts.

REPORT OF A DREDGING EXPEDITION OFF THE SOUTHERN COAST OF NEW ENGLAND, SEPTEMBER, 1899.

By FREELAND HOWE, Jr.

On July 29, 1880, the *Fish Hawk* left the builder's yard at Wilmington, Del., and proceeded to Newport, R. I., and after some preliminary dredging in the shallow water off the southern coast of New England started for the locality where the tile-fish had been discovered in May, 1879. The remarkable results of the work of September 4, September 13, and October 2, 1880, were published in the American Journal of Science, November, 1880, and created general comment among men of science, for it had been thought improbable that such a wealth of marine life existed on this portion of the sea bottom. During the following year the *Fish Hawk* made seven excursions to the edge of the continental elevation, and Professor Verrill wrote:

> It is probable that the remarkable richness of the fauna in this region, both in the number of species and in the surprising abundance of the individuals of many of them, is due very largely to the unusual uniformity of the temperature enjoyed at all seasons of the year at all those depths that are below the immediate effects of the atmospheric changes. The region under discussion is subject to the combined effects of the Gulf Stream on one side and the cold northern current on the other, together with the gradual decrease in temperature in proportion to the depth. * * * The vast quantities of free-swimming animals continually brought northward by the Gulf Stream and filling the water, both at the surface and bottom, furnish an inexhaustible supply of food for many of the animals inhabiting the bottom, and probably directly, or indirectly, to nearly all of them. (Report U. S. Fish Commission, 1882, p. 642.)

In the spring of 1882 many forms of life on this portion of the sea bottom were almost exterminated, although the *Fish Hawk* found an abundance of animal life at certain localities. The following year the *Fish Hawk* made only one excursion to the Gulf stream, and the dredges were not lowered into water deeper than 62 fathoms. Although the *Albatross* dredged in the region in 1883, 1884, and 1885, no serious biological examination of this portion of the sea bottom was made until 1899. It was because the results attending a reexamination of this area would prove of considerable scientific interest that arrangements were made for the excursion herein described.

On August 31, 1899, the *Fish Hawk*, under command of Capt. J. A. Smith, left Woods Hole with Prof. H. C. Bumpus and other members of the biological laboratory, and at 5 a. m. September 1st arrived at the spot where nineteen years before the wonderful marine fauna had been discovered.

The principal piece of collecting apparatus was a 7-foot beam trawl. An attempt was made to use a large surface net, but the leverage interfered so materially with the steering of the vessel that its continued use was found to be impracticable. Small tow nets and long-handled dip nets were used in its place. Most of the material was

preserved in 5 per cent formalin. The day was such as to promise excellent surface collecting; the air was calm and the water smooth. Large numbers of chain salpas were seen swimming near the surface and below as far as the sight could penetrate. The chains varied in length from an inch to several feet, and solitary individuals, or those arranged in rings, occasionally drifted by. The longer chains moved through the water much more rapidly than the smaller ones, and in addition to the branchial action they exhibited distinct serpentine movements. The salpas were not present during the midday hours, and my observations would indicate that they were not present at the surface on cloudy or windy days.

In the forenoon 4 dredgings were made, and at each station the trawl was on the bottom from 15 to 30 minutes. The afternoon and evening were spent in the course homeward, the latter part of the journey being through water of remarkable phosphorescence. At about midnight the vessel came to anchor off Nobsque light.

On this excursion fully 100 species of animals were collected, and many of the hauls brought up a surprising variety of bottom forms. A much larger number would doubtless have been recorded if the means for picking over and sorting the material had been adequate and if there had been more time for working up the material preserved. Inasmuch as the four stations were quite near one another, it has not been thought necessary to arrange the specimens in separate groups.

Table of stations at which dredgings were made on September 1, 1899.

[The distances are measured from Gay Head Light in nautical miles.]

Station.	Lat. N.	Long. W.	Locality off Gay Head.	Faths.	Bottom.	Date.	Temperature.		Hour.
							Bottom.	Surface.	
	° ′ ″	° ′					° F.	° F.	
7068	40 04 00	70 20	S. 80 miles...	95	Hard sand	Sept. 1	52.4	71.6	5.05 a.m.
7069	40 01 30	70 21	S. 82 miles...	122	.....do.....	....do...	50.7	73.94	6.55 a.m.
7070	39 58 30	70 16	S. 88 miles...	198	Sand, mud	....do...	48.6	74.12	8.45 a.m.
7071	39 59 30	70 19	S. 87 miles...	168	.....do.....	....do...	49.2	75.74	10.25 a.m.

LIST OF SPECIMENS.

In the following list the previously ascribed range of each species is given. The fish were identified by Dr. Hugh M. Smith and Mr. Barton A. Bean. It will be noticed that 8 species are recorded from new localities. The pelagic copepoda collected are accounted for in a special paper by Prof. W. M. Wheeler, entitled "The Free-swimming Copepods of the Woods Hole region," in the Bulletin of the United States Fish Commission for 1899, pages 157–192:

CŒLENTERATA.

Pelagia cyanella Peron & Le Sueur. Caribbean Sea to St. Georges Bank. One specimen. Surface.

Medusa. Dr. R. P. Bigelow, of Boston, Mass., states that this form seems to belong to a new genus and species of *Æginidæ*, which will shortly be described. One specimen. Surface. Sta. 7068.

Pennatula aculeata Koren & Danielssen. Range, 97 to 1,255 fathoms. Ten specimens. Trawled.

Adamsia sociabilis Verrill. Range, 79 to 410 fathoms. Abundant as commensal of *Catapagurus sharreri*. Trawled.

Epizoanthus americanus Verrill. Range, off New Jersey to Gulf of St. Lawrence. Hundreds of specimens growing on gasteropod shells inhabited by *Eupagurus pubescens*. Trawled.

Sagartia abyssicola (Koren & Danielssen) Verrill. Range, 69 to 640 fathoms. Generally two or three occurred on each tube of *Hyalinœcia artifex*, of which thousands were trawled.

Urticina perdix Verrill. Range, 63 to 190 fathoms. Several specimens obtained by schooner *Grampus* on trawls set for tile-fish.

Actinauge nodosa Fabr. Range, 86 to 1,098 fathoms. About 20 specimens. Trawled.

Bolocera tuediæ Gosse. Range, 37 to 1,106 fathoms. One specimen. Trawled.

Tealia crassicornis Gosse? Range, North Sea and Baltic. One specimen. Trawled.

Dasmosmilia lymani Pourtales. Range, 65 to 179 fathoms. Six specimens. Trawled.

VERMES.

Hyalinœcia artifex Verrill. Range, 150 to 640 fathoms. Trawled by thousands, each tube generally bearing two or three *Sagartia abyssicola*.
Nothria conchyphila Verrill. Range, 100 to 300 fathoms. Six specimens. Trawled.
Lepidonotus squamatus Leach. Range, Atlantic Ocean. About 50 specimens. Trawled.
Aphroditea aculeata Linnæus. One specimen trawled in Färöe Channel in 530 fathoms.
Cerebratulus luridus Verrill. Range, 64 to 192 fathoms. Three specimens. Trawled.
Three long rubber-like tubes, about 3 feet long and 3 inches in diameter, possibly some worm-tube.

MOLLUSCOIDA.

Bugula sp. Very abundant on sargassum. Surface.
Polyzoan. Several specimens growing on broken bottle. Trawled.
Membranipora sp. Very abundant on fronds and vesicles of sargassum. Surface.
Terebratulina septentrionalis Couthouy. Range, 16 to 396 fathoms. Three whole shells. Trawled.

ECHINODERMATA.

Linckia sp. Twelve specimens. Trawled.
Poraniomorpha borealis Verrill. Range, 192 to 225 fathoms. Two specimens. Trawled.
Diploaster multipes Sars. Range 124 to 640 fathoms. Two specimens. Trawled.
Archaster agassizii Verrill. Range, 182 to 1,342 fathoms. Five specimens. Trawled.
Archaster (*robustus?*) Verrill. Range, 938 to 1,467 fathoms. Five specimens. Trawled.
Scizaster fragilis Düben & Koren. Range, 225 to 321 fathoms. Ten specimens. Trawled.
Ophiopholis aculeata Gray. Range, shore to 1,000 fathoms. About 20 specimens. Trawled.
Ophioscolex glacialis Müller & Troschel. Range, 101 to 1,000 fathoms. Several hundred. Trawled.
Ophiacantha (*segesta?*) Lyman. The specimens most resemble the species *segesta* taken by the *Challenger* near the Philippines. Numerous. Trawled.
Ophiuran. Can not be referred to any described species.
Thyone recurvata Théel. Range, Kerguelen Islands, 10 to 100 fathoms. Nine specimens. Trawled.
Antedon dentata (Say) Verrill. Range, 69 to 640 fathoms. Hundreds. Trawled.

MOLLUSCA.

Cuspidaria fraterna Verrill & Bush. Range, N. lat. 40°, W. long. 69°, and N. lat. 39°, W. long. 74°, 302 to 984 fathoms. Three specimens. Trawled.
Lucina filosa Stimpson. Range, 4 to 349 fathoms. Two whole shells. Trawled.
Yoldia sapotilla Gould. Range, 125 to 321 fathoms. One live specimen. Trawled.
Astarte quadrans Gould. Range, 11 to 100 fathoms. Four live specimens. Trawled.
Cyprina islandica Lamarck. Range, 8 to 128 fathoms. One live specimen. Trawled.
Anomia aculeata Müller. Range, shore to 640 fathoms. Several specimens on broken bottle and on shells of *Fusus islandicus*. Trawled.
Chiton sp. One specimen recorded by Dr. Mulligan, but not found in preserved specimens.
Fusus islandicus Martini. Range, 16 to 300 fathoms. About 30 shells inhabited by *Eupagurus politus*; 3 contained the animals; several served for attachment of *Anomia aculeata*. Trawled.
Fusus ventricosus Gray. Range, bank fishing-grounds. Two shells inhabited by Eupagurids. Trawled.
Fusus pigmæus Stimpson. Range, North Atlantic. Six shells inhabited by Eupagurids. Trawled.
Torellia fimbriata Verrill & Smith. Range, 142 to 321 fathoms. One live specimen. Trawled.
Lunatia grœnlandica Stimpson. Range, 125 to 368 fathoms. Two shells inhabited by small *Eupagurus politus*. Trawled.
Lunatia heros Stimpson. Range, shore to 238 fathoms. Five shells inhabited by Eupagurids. Trawled.
Aporrhais occidentalis Sowerby. Range, 34 to 640 fathoms. About 20 shells, nearly all inhabited by Eupagurids; one shell bearing *Sagartia abyssicola*. Trawled.
Trochus (*Ziziphanus*) *tinctus* Watson. Range, 38 fathoms. Two shells. Trawled.
Scaphander mundus Watson. Range, 800 fathoms off Arrow Island. One live specimen and one shell. Trawled.
Pleurobranchia tarda Verrill. Range, 28 to 640 fathoms. Several specimens. Trawled.
Argonauta argo Linnæus. Range, 64 to 487 fathoms. One broken shell. Trawled.
Rossia sublevis Verrill. Range, 115 to 640 fathoms. Several specimens. Trawled. These contain a new *Dicyemid* which will be described by Prof. W. M. Wheeler.

CRUSTACEA.

Ceraphilus agassizii Smith. Range, 263 to 959 fathoms. One specimen. Trawled.
Pontophilus brevirostris Smith. Range, 51 to 233 fathoms. About 10 specimens. Trawled.
Hippolyte sp. About 30 specimens. Surface.
Anomalopus frontalis A. M.-Edwards. Range, 100 fathoms off Barbados; 75 fathoms off Florida. About 20 specimens. Trawled.
Pandalus annulicornis Leach. Range, Mediterranean; east coast of America, etc. Ten specimens. Trawled.

Spirontocaris spinus Sowerby. Range, 85 fathoms south of Halifax. One specimen. Trawled.
Munidia caribæa Smith. Range, 56 to 264 fathoms. About 30 specimens, some with eggs. Trawled.
Nephropsis agassizii A. M.-Edwards. Range, West Indies. One specimen taken at Station 7068. Very rare. When taken was a very brilliant red. Trawled.
Nautilograpsus minutus Milne-Edwards. Occurs with sargassum. One specimen. Surface.
Cancer borealis Stimpson. Shore to 435 fathoms; south to Cape Hatteras. One specimen. Trawled.
Neptunus sayi Stimpson. Occurs with sargassum. About 100 specimens taken in sargassum, nearly all females carrying eggs. Surface.
Catapagurus sharreri A. M.-Edwards. Range, 51 to 264 fathoms. Abundant as commensal of *Adamsia sociabilis*. Trawled.
Eupagurus kröyeri Stimpson. Range, 35 to 640 fathoms. One large specimen having no "house shell." Trawled.
Eupagurus pubescens Stimpson. Range, 26 to 86 fathoms. Abundant as commensal of *Epizoanthus americanus*. Trawled.
Eupagurus politus Smith. Range, 31 to 640 fathoms. About 30 specimens inhabiting large *Fusus* shells; one small specimen in shell of *Fusus pigmæus;* two small specimens in shells of *Lunatia heros;* two small ones in shells of *Lunatia grœnlandica;* about 20 small ones in shells of *Aporrhais occidentalis*. Trawled.
Latreutes ensiferus Stimpson. With gulf weed. About 50 specimens, some parasitized by a *Bopyrus*. Surface.
Epimera loricata G. O. Sars. Range, 90 to 640 fathoms. Ten specimens. Trawled.

TUNICATA.

Molgula sp. Several specimens covered with small sand particles.
Salpa sp. Large, solitary form, about 6 cm. long.
Salpa cordiformis-zonaria Quoy & Gaimard. Very plenty in chain form, a few solitary individuals with characteristic, broader muscle bands being taken. A tunic 75 mm. long, containing a dead and much contracted animal, was trawled. The size of the individuals of the chain as well as the length of the chains varied considerably. The individuals were in various stages of reproduction. Surface.
Cyclosalpa (*pinnata?*) Forskåhl. Range, Pacific Ocean between Papua and Japan. Several colonies in various stages of reproduction. These forms are of especial interest, as Herdman in Challenger Expedition Report records only one poor specimen of a solitary individual. Surface.

PISCES.

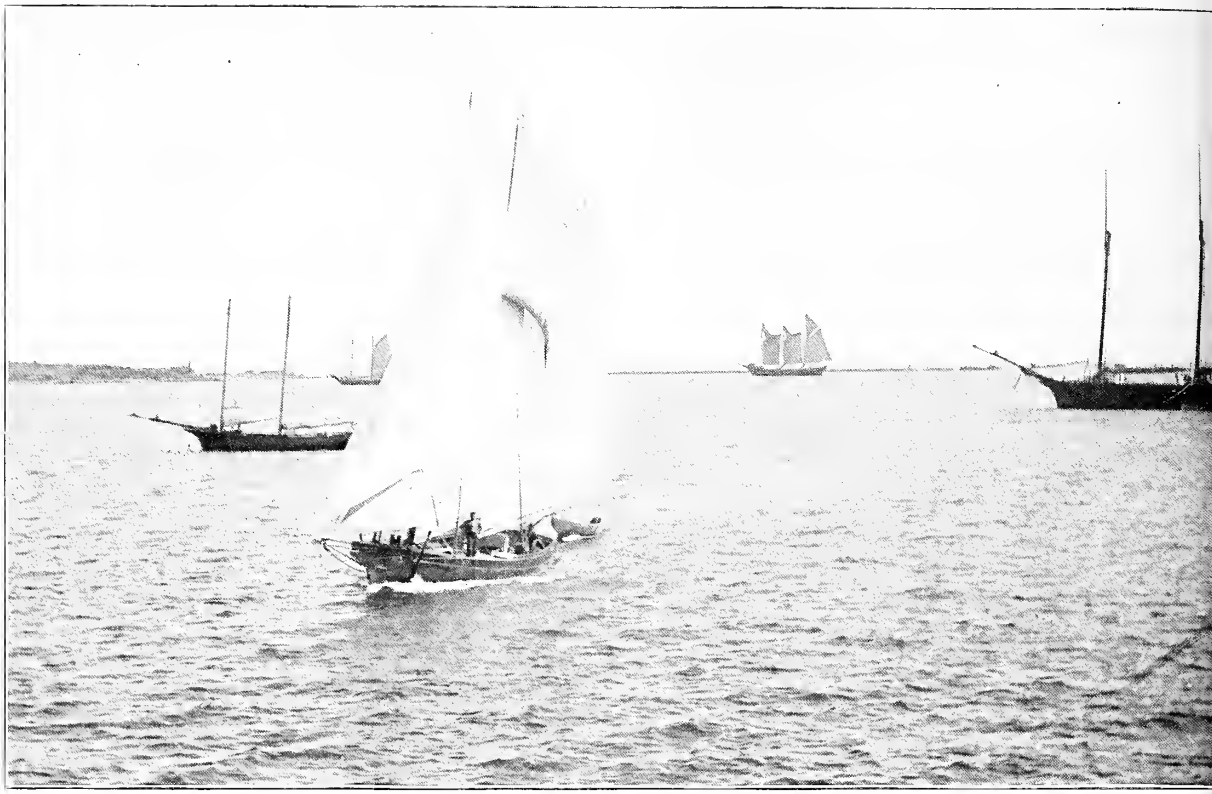
I. Surface Species.

Seriola fasciata (Bloch). Range, West Indies north to Charleston, S. C. One specimen.
Trachurops crumenophthalmus (Bloch). Range, Atlantic coast of United States. Two specimens.
Caranx crysos (Mitchill). Range, Cape Cod to Brazil. One specimen.
Glossamia pandionis (Goode & Bean). Range, deep water off Chesapeake Bay. One specimen.
Abudefduf saxatilis (Linnæus). Range, both coasts of tropical America. One specimen.
Balistes vetula Linnæus. Range, tropical parts of the Atlantic, Gulf Stream to Woods Hole. One specimen.
Monacanthus hispidus (Linnæus). Range, Cape Cod to Brazil. Several specimens.
Lycenchelys verrillii (Goode & Bean). Range, coast of Massachusetts and northward. One specimen.
Merluccius bilinearis (Mitchill). Range, coast of New England and northward. Two specimens.

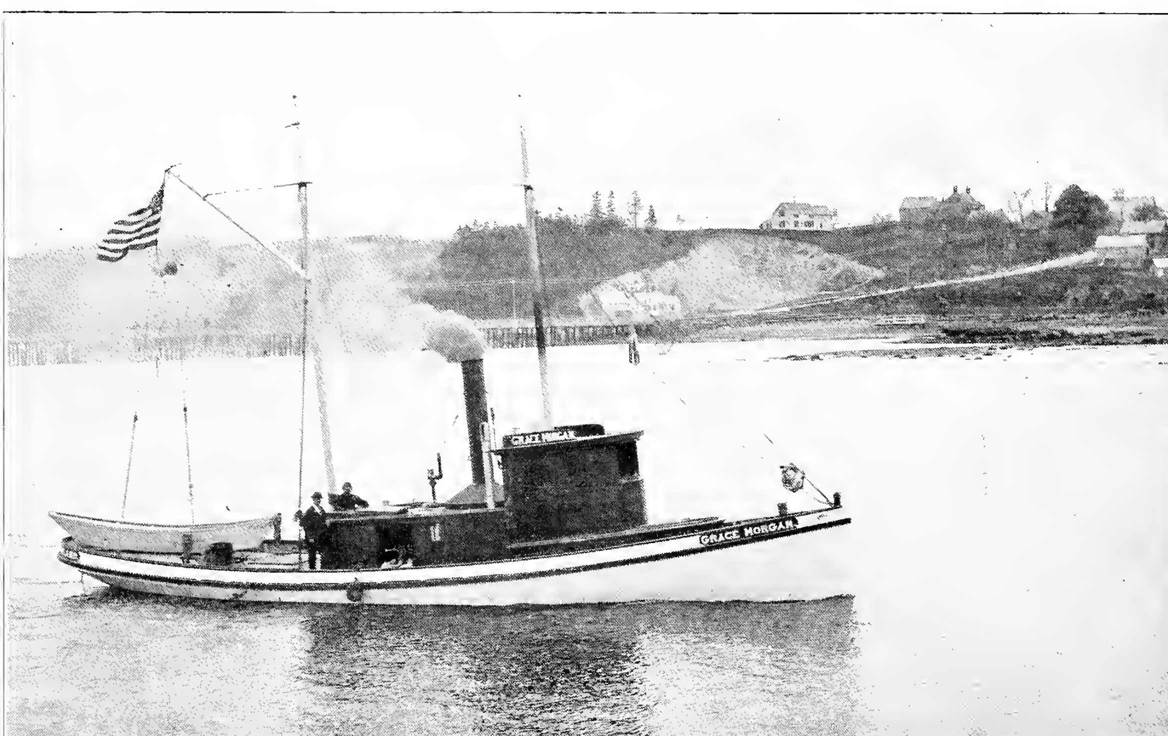
II. Deep-water Species.

Raia eglanteria Bosc. Range, Cape Cod southward to Florida. One specimen.
Helicolenus maderensis Goode & Bean. Range, deep waters of Atlantic coast from Narragansett Bay to Chesapeake Bay. One specimen.
Peristedion miniatum Goode. Range, Gulf Stream. Two fine, large specimens.
Macrourus bairdii Goode & Bean. Range, West Indies to Massachusetts Bay. One specimen.
Citharichthys arctifrons Goode. Range, deep waters of Gulf Stream. Thirty specimens.
Monolene sessilicauda Goode. Range, deep waters of Gulf Stream. Two specimens.
Symphurus pusillus (Goode & Bean). Range, off Atlantic coast of United States, in deep water. One specimen.
Dibranchus atlanticus Peters. Range, Gulf Stream. Several specimens.

Harvard University, *December 30, 1899.*



THE SAILING SMACK "BAR BEL." OF ROCKLAND.



THE FIRST STEAM SMACK TO CARRY LOBSTERS IN A WELL.

THE LOBSTER FISHERY OF MAINE.

By JOHN N. COBB,
Agent of the United States Fish Commission.

For some years past the condition of the lobster fishery of New England has excited the earnest attention of all interested in the preservation of one of the most valuable crustaceans of our country. In the State of Maine, particularly, where the industry is of the first importance, the steady decline from year to year has caused the gravest fears, and incessant efforts have been made by the United States Fish Commission, in conjunction with the State Fish Commission of Maine, to overcome this decline. This paper presents the results of an investigation by the writer in 1899. All statistics, when not otherwise stated, are for the calendar year 1898.

I am indebted to so many dealers, fishermen, and others for information given and courtesies extended that it is impossible to mention them by name, and I now extend to all my most sincere thanks for their many kindnesses.

NATURAL HISTORY OF THE LOBSTER.

Although the lobster has been of great value to the New England States and the British Provinces as a food commodity, but little was known of its life-history and habits until within the last few years. To this ignorance has been due quite largely the peculiar (and in some instances useless) laws enacted by some States. The gradual enlightenment of the public on this subject has borne good fruit, however, and most of the present State laws are founded on substantial facts instead of theories. Prof. Francis H. Herrick has been one of the most prominent of the investigators, and his summary of the present knowledge on this subject is quoted below from the Fish Commission Bulletin for 1897:

(1) The fishery is declining, and this decline is due to the persistence with which it has been conducted during the last twenty-five years. There is no evidence that the animal is being driven to the wall by any new or unusual disturbance of the forces of nature.

(2) The lobster is migratory only to the extent of moving to and from the shore, and is, therefore, practically a sedentary animal. Its movements are governed chiefly by the abundance of food and the temperature of the water.

(3) The female may be impregnated or provided with a supply of sperm for future use by the male at any time, and the sperm, which is deposited in an external pouch or sperm receptacle, has remarkable vitality. Copulation occurs commonly in spring, and the eggs are fertilized outside the body.

(4) Female lobsters become sexually mature when from 8 to 12 inches long. The majority of all lobsters 10½ inches long are mature. It is rare to find a female less than 8 inches long which has spawned or one over 12 inches in length which has never borne eggs.

(5) The spawning interval is a biennial one, two years elapsing between each period of egg-laying.

(6) The spawning period for the majority of lobsters is July and August. A few lay eggs at other seasons of the year—in the fall, winter, and probably in the spring.

(7) The period of spawning lasts about six weeks, and fluctuates slightly from year to year. The individual variation in the time of extrusion of ova is explained by the long period during which

the eggs attain the limits of growth. Anything which affects the vital condition of the female during this period of two years may affect the time of spawning.

(8) The spawning period in the middle and eastern districts of Maine is two weeks later than in Vineyard Sound, Massachusetts. In 1893 71 per cent of eggs examined from the coast of Maine were extruded in the first half of August.

(9) The number of eggs laid varies with the size of the animal. The law of production may be arithmetically expressed as follows: *The number of eggs produced at each reproductive period varies in a geometrical series, while the length of lobsters producing these eggs varies in an arithmetical series.* According to this law an 8-inch lobster produces 5,000 eggs, a lobster 10 inches long 10,000, a 12-inch lobster 20,000. This high rate of production is not maintained beyond the length of 14 to 16 inches. The largest number of eggs recorded for a female is 97,440. A lobster 10½ inches long produces, on the average, nearly 13,000 eggs.

(10) The period of incubation of summer eggs at Woods Hole is about ten months, July 15–August 15 to May 15–June 15. The hatching of a single brood lasts about a week, owing to the slightly unequal rate of development of individual eggs.

(11) The hatching period varies also with the time of egg-laying, lobsters having rarely been known to hatch in November and February.

(12) Taking all things into consideration, the sexes appear about equally divided, though the relative numbers caught in certain places at certain times of the year may be remarkably variable.

(13) Molting commonly occurs from June to September, but there is no month of the year in which soft lobsters may not be caught.

(14) The male probably molts oftener than the female.

(15) In the adult female the molting like the spawning period is a biennial one, but the two periods are one year apart. As a rule, the female lays her eggs in July, carries them until the following summer, when they hatch; then she molts. Possibly a second molt may occur in the fall, winter, or spring, but it is not probable, and molting just before the production of new eggs is rare.

(16) The egg-bearing female, with eggs removed, weighs less than the female of the same length without eggs.

(17) The new shell becomes thoroughly hard in the course of from six to eight weeks, the length of time requisite for this varying with the food and other conditions of the animal.

(18) The young, after hatching, cut loose from their mother, rise to the surface of the ocean, and lead a free life as pelagic larvæ. The first larva is about one-third of an inch long (7.84 mm.). The swimming period lasts from six to eight weeks, or until the lobster has molted five or at most six times, and is three-fifths of an inch long, when it sinks to the bottom. It now travels toward the shore, and, if fortunate, establishes itself in the rock piles of inlets of harbors, where it remains until driven out by ice in the fall or early winter. The smallest, now from 1 to 3 inches long, go down among the loose stones which are often exposed at low tides. At a later period, when 3 to 4 inches long, they come out of their retreats and explore the bottom, occasionally hiding or burrowing under stones. Young lobsters have also been found in eelgrass and on sandy bottoms in shallow water.

(19) The food of the larva consists of minute pelagic organisms. The food of the older and adult stages is largely of animal origin with but slight addition of vegetable material, consisting chiefly of fish and invertebrates of various kinds. The large and strong also prey upon the small and weak.

(20) The increase in length at each molt is about 15.3 per cent. During the first year the lobster molts from 14 to 17 times. At 10½ inches the lobster has molted 25 to 26 times and is about 5 years old.

As the purpose of this article is to deal more particularly with the commercial side of the lobster question all interested more particularly in the natural history of the animal are referred to the following works:

The Fisheries and Fishery Industries of the United States, sec. I, pp. 780–812.
The American Lobster, by Francis H. Herrick. Bull. U. S. Fish Com. for 1895, pp. 1–252.

HISTORY OF THE FISHERY.

Ever since the early Puritan settlers first learned from the Indians how to utilize the lobster, it has been one of the most prized articles of food in the New England States. The early town records of Massachusetts contain frequent references to this valuable crustacean, and efforts were made at an early day to conserve the supply.

At first, as most settlers lived on or near the coast, each family could easily secure its own supply, but as the settlements gradually extended farther inland this became inconvenient, and it soon became customary for certain persons living on the coast to attend to supplying the wants of the inland settlers, and thus the commercial fishery was established.

The coast of Maine is very favorably situated for this fishery. In its eastern and middle sections the shore is bold and rocky, while it is cut up by large deep inlets and coves which are studded with numerous islands, large and small, and by bold rocky promontories. Groups of islands are also numerous farther off shore, like the Fox and Matinicus Islands, Deer and Mount Desert islands. Large and small fresh-water rivers are numerous and the granite bottoms of these channels and inlets form admirable breeding-grounds. In the western end the shores are not so rocky, being broken frequently with sandy reaches, while the rivers are small and comparatively shallow. West of Casco Bay the islands are infrequent. As a result of this conformation of coast the best fishing-grounds in Maine are between Cape Elizabeth and Quoddy Head.

As early as 1830 smacks from Boston and Connecticut visited Harpswell for fresh lobsters, and it is very probable that even before this time they had visited the points farther west in the State, as the history of the fishery, so far as known, shows that it gradually worked to the eastward. This was doubtless owing to the fact that the trend of settlement in the early part of the century was in that direction. It is also probable that, for some time before the people along the coast took up the fishery, the smackmen themselves did their own fishing. This is easily believed when the great abundance is considered. It is known that this was done in Massachusetts.

During summer the lobsters were very common close in shore and could easily be gaffed by boys at low water; but this could hardly be called a regular fishery.

The regular fishery began with the use of hoop-net pots, which were generally of very rude construction, and the facility with which the lobsters escaped from them led to their disuse soon after the lath pots began to be introduced. The lath pots were essentially the same in construction as those now used on the coast of Maine, and each pair of fishermen then handled between 25 and 50.

Up to about 1865 it was the custom to set the traps singly, and two men were usually employed in the fishery, one to haul up, empty the pot, rebait it, and drop it overboard, while the other handled the boat. In the latter year it was discovered that by setting the pots on trawls more pots could be set and only one man would be required to work them. This invention, which was claimed by several different persons, proved quite successful for a while, but after a time, when the supply of lobsters began to drop off, better results were secured by scattering the pots over a greater area and shifting their position each time they were fished, which was very easily done. As a result of this the use of trawls decreased very rapidly.

The following facts regarding the early lobster fishery of Maine are from the Fishery Industries of the United States, section V, vol. II, pp. 700, 701:

In 1841 Capt. E. M. Oakes began to carry lobsters from Cundy's Harbor and Horse Island Harbor, Harpswell, to Mr. Eben Weeks, at East Boston. He was then running a well-smack, named the *Swampscott*, of 41 tons, old measurement. The season extended from the 1st of March until about the 4th of July, after which time the lobsters were supposed to be unfit for eating; the black lobsters, or shedders, were even considered poisonous. During this season of four months Captain Oakes made ten trips, carrying in all 35,000, by count. He continued in this trade about six years, taking the combined catch of about five or six fishermen. At this same period the smack *Hulda B. Hall*, 50 tons,

of New London, Conn., Captain Chapell, was carrying lobsters from Cape Porpoise, Gloucester, Ipswich Bay, and occasionally Provincetown, to Boston, making 15 trips in the season of four months, and taking about 3,500 lobsters each trip. Captain Chapell was supplied with lobsters by four men at Cape Porpoise, and by the same number at both Gloucester and Ipswich Bay. For four months following the close of the lobster season on the Maine coast, or from July 4 until November, Captain Chapell ran his smack with lobsters to New York, obtaining most of his supplies at Provincetown.

In 1847 Captain Oakes purchased the smack *Josephine*, with which he began running to Johnson & Young's establishment, at Boston, in 1848, buying a portion of his lobsters in the Penobscot Bay region, where this fishery had just been started. The quantity of lobsters carried by him that year was 40,000. The prices paid to the fishermen for smack lobsters was as follows: During March, 3 cents each; April, 2½ cents; May and June, 2 cents. In 1850, he began to obtain supplies from the Muscle Ridges, leaving Harpswell entirely, on account of the small size of the lobsters then being caught there. At this time the average weight of the lobsters marketed was about 3 pounds, and all under 10½ inches in length were rejected. The traps were made of the same size as at present, but were constructed of round oak sticks, and with four hoops or bows to support the upper framework. A string of bait, consisting mainly of flounders and sculpins, was tied into each trap. About 50 traps were used by each fisherman, and they were hauled once a day. The warps or buoy lines, by which the traps were lowered and hauled, were cut in 12-fathom lengths. Lobsters were so abundant at the Muscle Ridges, at this period, that four men could fully supply Captain Oakes with lobsters every trip. In the course of ten days each man would obtain between 1,200 and 1,500 marketable lobsters. In Captain Oakes's opinion, the Muscle Ridges have furnished the most extensive lobster fishery of the Maine coast. He ran to this locality until 1874.

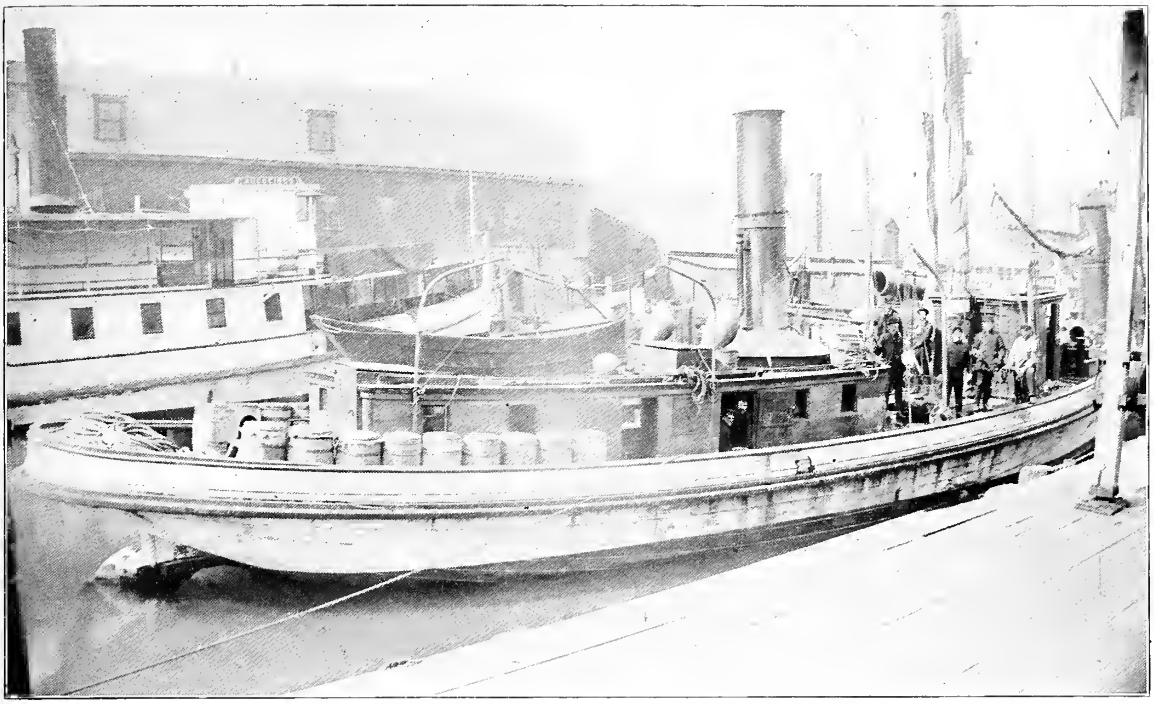
Capt. S. S. Davis, of South Saint George, states that about 1864, when he first began buying lobsters at the Muscle Ridges, three men, tending 40 to 50 pots each, caught all the count lobsters he could carry to market in his smack. He could load 5,000 lobsters at a time, and averaged a trip in 7 to 9 days. This traffic continued for six or seven years. In 1879, Captain Davis bought from 15 men in the same locality, and at times was obliged to buy also of others in order to make up a load.

The fishery at North Haven began in 1848, but did not increase so rapidly at first as in sections farther west, as the smacks would only take the medium-sized lobsters, fearing that the largest would not be able to stand the trip. At Matinicus Island the fishing began in 1868. In 1852 the people on Deer Island began the fishery, and as the smackmen made frequent visits the business rapidly increased. The establishment of a cannery at Oceanville, about 1860, also caused a considerable development of the fishery. The fishery was started at Isle au Haute about 1855, and at Swan Island in the early fifties.

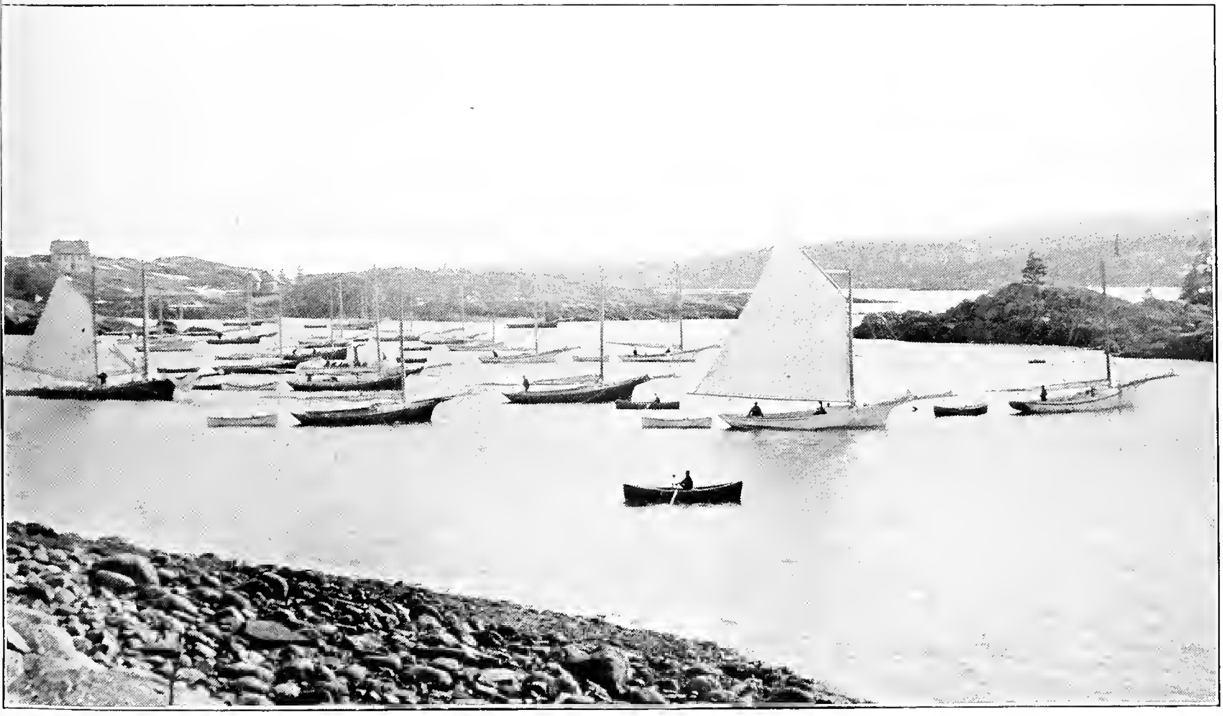
The canning of lobsters was first carried on at Eastport in 1842, but the fishery was not taken up until about 1853, as it was supposed there were no lobsters in the neighborhood. The supplies for these canneries previous to the inception of the fishery were obtained by smacks running to the westward.

For some years the fishery was only prosecuted in the late spring, summer, and early fall months. Just when winter fishing began in the State is doubtful; but according to Capt. Charles Black, of Orr Island, it began in that region in 1845 at Harpswell. Previously the fishermen had the impression that lobsters could not be successfully caught earlier than March 20.

During the summer of 1845 the captains of the well-smacks of New London, Conn., who bought most of the lobsters in that vicinity, induced Charles E. Clay, Samuel Orr, and a few others to fish during the winter, and they set their traps about the same distance from the shore that the fishermen do at present, and in almost the same depth of water. The smackmen paid them $4 for 100 lobsters. The next winter the fishermen refused to sell by number and wanted $1.25 per 100 pounds. The smackmen had no objection to buy them by weight, but refused to pay more than $1.12 per 100 pounds. This was accepted, and for several years the prices were from $1.12 to $1.25 per 100 pounds.



THE STEAM SMACK "MINA AND LIZZIE" LANDING HER CARGO AT PORTLAND.



FLEET OF LOBSTER BOATS IN HARBOR AT YORK ISLAND.

Comparatively few traps were necessary then, as when the weather would permit the fishermen to tend their traps they would catch from 20 to 30 lobsters daily, and frequently, when the traps were hauled, they would find several lobsters clinging to some part of the pots. The bait was very plentiful and caught with spears.

The lobsters were placed in cars at that time, after having been "plugged" to keep them from injuring each other. The plugs were almost 1½ inches long, flat on one side, round on the other, and with a sharp point. Plugging has since been discontinued, as the trifling injury the lobsters did each other was nothing compared to the value of cans of meat spoiled by one of these pine plugs being boiled with it.

THE FISHING-GROUNDS.

It is difficult to estimate the comparative value of the grounds in the State, owing to the movements of the lobsters. In the early spring, in April or May, as the waters in the bays and rivers warm up, the lobsters come into the comparatively shallow waters. They remain here until late in the fall, going back to the ocean or deep waters of the bays in either October or November. They love to congregate on rocky bottom, and pots set on such bottom will frequently make large catches, while those on sandy or muddy ground will catch almost nothing. In the early years of the fishery they came in very close in great numbers, and could frequently be taken at low water in dip nets or by gaffs; but they are now found in summer in depths of from 3 to 15 fathoms in the numerous passages between the islands and the mainland, and the lower reaches of the bays and rivers. For a number of years winter fishing was not prosecuted, but now it is a very important business. In winter the pots are generally set in the ocean at depths of from 15 to 50 fathoms.

As the greatest part of the coast line is cut up by numerous bays and rivers, and these are dotted with large and small islands, they form admirable breeding-grounds for the lobster. Some of the best locations are in Little Machias, Machias, Englishman, Pleasant Point, Chandler, Narragaugus, Muscongus, Linekin, Sheepscot, and Casco bays, while the fishing is especially good around the numerous islands in the lower Penobscot and Blue Hill bays, and at Monhegan and the Matinicus islands in the ocean. The Sheepscot River is also a favorite resort for lobsters during the warm months, while in the winter they retire to the waters of the bay, where the fishing can be carried on very easily. At most of the other grounds the winter fishing is carried on in the ocean, as the lobsters do not usually remain in the bays. Most of the fishing in Casco Bay is carried on at the eastern end among the numerous islands. The earliest fishing of which we have any definite record was carried on from the township of Harpswell on this bay. This region has held its own remarkably well, as in 1898 more than twice as many lobsters were taken by fishermen from this township than from any other town in the State.

The upper portions of Frenchman, Blue Hill, and Penobscot bays were formerly very important grounds, but are now almost exhausted. These regions were especially noted for large lobsters. In August, 1891, Mr. F. W. Collins, a Rockland dealer, had 50 lobsters in his establishment which weighed from 10 to 18½ pounds apiece. About half of these came from Castine, in upper Penobscot Bay, and the remainder from Blue Hill Falls, in the upper Blue Hill Bay.

The grounds in York County, at the western end of the State, were formerly quite prolific, but the excessive fishing of the last thirty years has very badly depleted them.

THE FISHING SEASON.

In the early days of the fishery it was customary to fish only during the spring and fall. When the canneries went into operation they usually worked during the spring, early summer, and fall, and as they furnished a ready market for all the lobsters that could be caught this came to be the principal season. At that time it was not thought possible to do any winter fishing, owing to the cold and stormy weather and the fact that the fishing had to be carried on generally in the open sea.

In 1878 a law was passed limiting the canning season to the period between April 1 and August 1. This season was frequently changed by subsequent enactments, but rarely covered a longer period than that fixed in the first law. As at certain places on the coast the canneries were the only market for lobsters the fishery would cease as soon as the canneries stopped. At other places, which were visited by the smacks, some of the fishermen would continue fishing after the canneries closed, selling to the smackmen. At various times a close season was in force, but at present there is no limitation as to season. The canning industry in the State practically ceased to exist in 1895, and since then the whole catch has had to be marketed in a live or boiled condition. The smack fleet had been gradually increasing as the live-lobster trade extended, and by the time the canneries closed permanently they had extended their visits to every point where lobsters could be had in any number.

At present the majority of the fishermen usually haul out their traps during July and August and put them in good order for the fall fishing. During the excessively cold portion of the winter most of the pots are taken out, but some fishing is done during every month of the year.

The fishermen on Monhegan Island, about 12 miles southeast of Pemaquid Point, agree among themselves to put no lobster pots in the water until about the 1st of January. There is then no restriction on fishing until about May 15, when all pots are hauled out and no more fishing is done until the season begins again. During this season the law in regard to short lobsters is rigidly enforced by the fishermen themselves. Should any outsider visit this island during the close time established by the fishermen, and attempt to fish, he is quietly informed of the agreement and requested to conform to it. Should he persist in working after this warning, his pots are apt to mysteriously disappear. As lobsters bring a much higher price in winter than in summer, the Monhegan fishermen reap a rich reward, as the lobsters are very numerous, owing to the 7½ months close time. On the first day the fishermen hauled in 1900 one man secured 293, for which he received 19 cents apiece. The smallest number secured by anyone was 135.

FISHING APPLIANCES.

In most large fisheries for certain species numerous changes occur at intervals in the apparatus used, owing to changed conditions, etc., but in the lobster industry changes have been few, and at an early period the fishermen fixed upon a uniform apparatus, which has been in use ever since with but slight modifications, and these generally only temporary.

The earliest form of apparatus used to any considerable extent was the hoop net. This consisted generally of a hoop or ring of about ½-inch round iron, or a wooden hogshead hoop, from 2½ to 3 feet or more in diameter. To this hoop was attached a net bag with a depth of 18 to 24 inches as a bottom, while two wooden half hoops were bent above it, crossing at right angles in the center about 12 or 15 inches above

the plane of the hoop. Sometimes these half hoops were replaced by short cords. The bait was suspended from the point of crossing of the two wooden hoops and the line for raising and lowering the pots was attached at the same place. As there was no way of closing the mouth of the pot after a lobster had entered, these nets had to be constantly watched, the lobster being in the habit of retiring after he had finished his repast. In using these the fisherman would generally go out in the evening and at short intervals he would haul in his nets and remove whatever lobsters they might contain. The constant attention necessary in attending to these hoop nets led the fishermen to devise an apparatus which would hold the lobsters after once entering and would require only occasional visits, and "lath pots" were found to fulfill all requirements. They acquire the name from the use of common laths in their construction. They are usually about 4 feet in length, with a width of about 2 feet, a height of 18 inches, and in Maine are usually of semicylindrical form.

The following description of this apparatus is from the Fishery Industries of the United States, sec. v, vol. II, p. 666:

> The framework of the bottom consists of three strips of wood, either hemlock, spruce, or pine (the first mentioned being the most durable), a little longer than the width of the pot, about $2\frac{3}{4}$ inches wide and 1 inch thick. In the ends of each of the outer strips a hole is bored to receive the ends of a small branch of pliable wood, which is bent into a regular semicircular curve. These hoops are made of branches of spruce or hemlock, or of hardwood saplings, such as maple, birch, or ash, generally retaining the bark. Three of these similar frames, straight below and curved above, constitute the framework of each pot, one to stand at each end and one in the center. The narrow strips of wood, generally ordinary house laths of spruce or pine, which form the covering, are nailed lengthwise to them, with interspaces between about equal to the width of the laths. On the bottom the laths are sometimes nailed on the outside and sometimes on the inside of the cross pieces. The door is formed by three or four of the laths running the entire length near the top. The door is hinged on by means of small leather strips, and is fastened by a single wooden button in the center, or by two buttons, one at each end. The openings into the pot * * * are two in number, one at each end, are generally knit of coarse twine and have a mesh between three-fourths of an inch and 1 inch square. They are funnel-shaped, with one side shorter than the other, and at the larger end have the same diameter as the framework. The smaller and inner end measures about 6 inches in diameter and is held open by means of a wire ring or wooden hoop. The funnels are fastened by the larger ends to the end frames of the pot, with the shorter side uppermost, so that when they are in place they lead obliquely upward into the pot instead of horizontally. The inner ends are secured in position by one or two cords extending to the center frame. The funnels are about 11 or 12 inches deep, and therefore extend about halfway to the center of the pot. They taper rapidly and form a strongly inclined plane, up which the lobsters must climb in their search for the bait. A two-strand manila twine is most commonly used for the funnels. Cotton is also used, but is more expensive and less durable.

A change in the shape of the funnel was first made at Matinicus shortly before 1890. This has been called the "patent head." Large lobsters are said to always go to the top and small ones to the bottom of the pots. By going to the top in the "old-head" pot large lobsters made their escape through the hole, but in the pots with "patent heads" instead of finding their way through the hole the big lobsters slide over it. The "patent head" has not been used to any extent, however. The sketch shown on the following page gives a good idea of the difference in shape.

In the center of the ordinary pot is a sort of spearhead of wood or iron from 8 to 12 inches long. This has one large barb and is set upright in the middle of the center frame. The bait is placed on this spearhead. Several large stones or bricks are lashed to the bottom of the pot, on the inside, in order to furnish weight enough to hold the pot at the bottom.

As it was noticed that a lobster generally crawled over a pot before entering by

the end, some pots of a square form and with the opening at the top were constructed, but they were not successful.

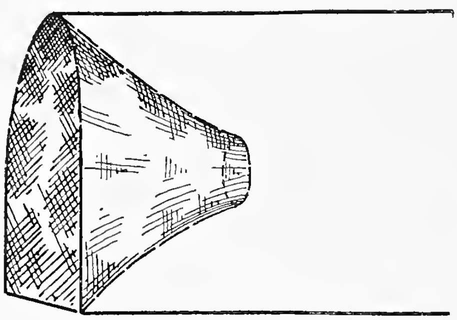
Another variation had a length of 7½ feet and five supporting frames inside instead of three, as in the old pot. These were set at equal distances apart, and had two more funnels than the other, one funnel being attached to each of the frames except the center one, and all pointing inward. In order to reach the bait the lobster had to pass through two funnels, and its chances of escape were thereby lessened. This style is rarely seen now.

Still another variety in vogue for a short time had a trapdoor, on which the lobster had to climb in order to reach the bait; the door then gave way and precipitated the lobster into a secure inclosure.

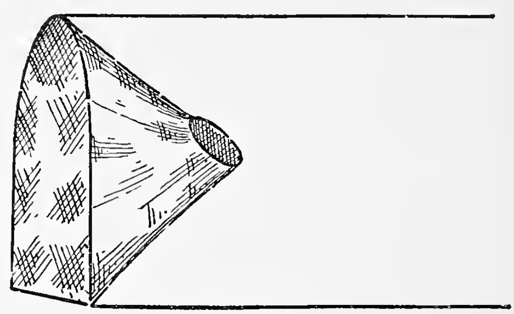
A few pots are made with a funnel of laths in place of the net funnels. They are the same as the ordinary pot in every other particular.

The ordinary pots cost about $1 to construct.

During certain seasons the pots are badly eaten by "worms," the shipworm (Teredo) or one of the species of small boring crustaceans. Pots are also frequently lost during stormy weather, and the fishermen therefore have a reserve stock on hand in order to replace those lost or temporarily disabled.



Old style of head (in general use.)

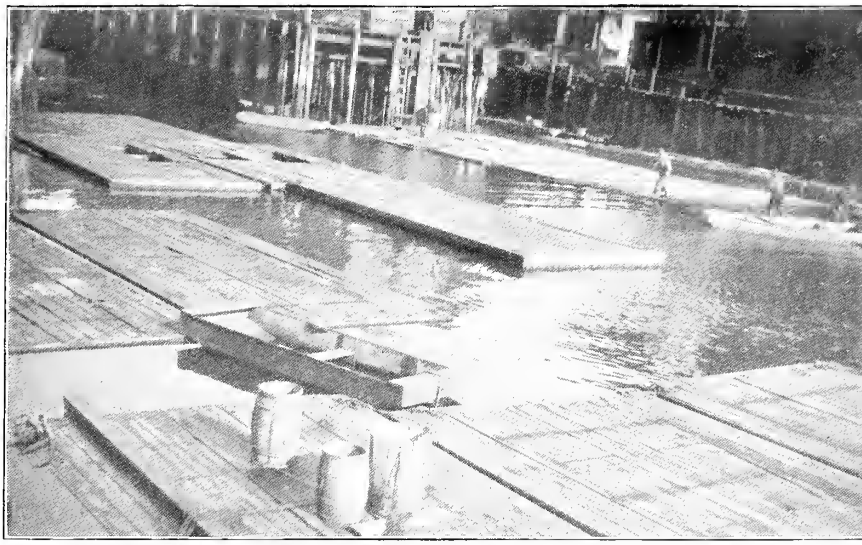


"Patent" head.

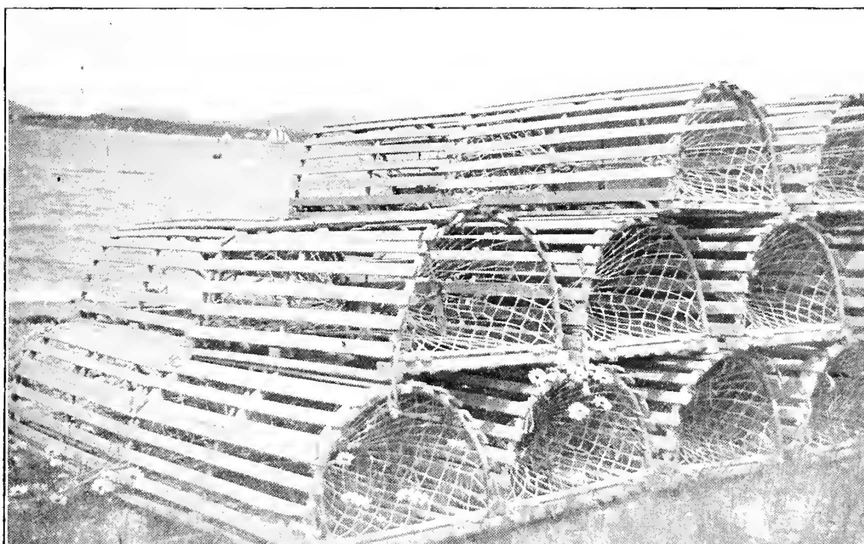
METHODS OF FISHING.

In fishing the traps are either set on single warps or on trawls of 8 to 40 and 50 pots. At first all pots were set singly. The line by which they were lowered and hauled up, and which also served as a buoy line, was fastened to one of the end frames of the bottom or sill, as it is called, at the intersection of the hoop. The buoys generally consist of a tapering piece of cedar or spruce, wedge-shaped, or nearly spindle-shaped, and about 18 inches long. They are usually painted in distinctive colors, so that each fisherman may easily recognize his own. Small kegs are also used as buoys.

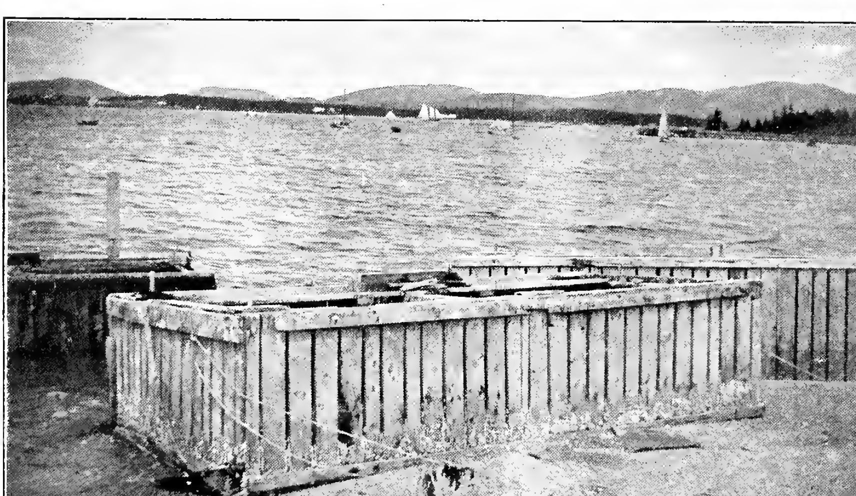
In the warm season the pots are frequently set on trawls or "ground lines," as lobsters are quite thick then on the rocky bottom near shore. If the bottom is sandy they are set farther from shore. Lobsters are most numerous on a rocky bottom. In the trawl method the pots are usually set about 30 feet apart, depending on the depth of water, so that when one pot is in the boat the next will be on the bottom. The ground lines have large anchors at each end and a floating buoy tied to a strong line, which is fastened to the ground line almost 25 fathoms from the anchors. When the last pot is hauled the anchor is far enough away to hold the boat in position. The pots



LOBSTER CARS USED IN THE WHOLESALE TRADE AT PORTLAND.



LOBSTER POTS.



FISHERMEN'S LOBSTER CARS.

are set at distances from the shore ranging from 100 yards to 5 or 6 miles. This method of setting pots was first used about the year 1865 in Sagadahoc County. The traps are set in from 3 to 10 fathoms in the warm season.

In winter fishing the pots are generally set singly, as the lobsters are more scattered then and the best results are attained by shifting the position of the pots slightly each time they are fished. This is caused by the drift of the boat while the fisherman is hauling in the pot, emptying and rebaiting it, and then dropping it overboard again. The winter fishing is generally carried on in the open sea, although in a few places, like Sheepscot Bay, the lobsters in winter retire to the deep waters of the bays and can there be caught. The pots are generally set in from 20 to 50 fathoms of water at this season.

Certain fishermen claim that when pots are set on a trawl placed across the tide the catch is greater than when the trawl is set in the direction of the current. In the former case, it is asserted, the scent or fine particles coming from the bait is more widely diffused and more apt to attract the lobsters. In entering, after first reconnoitering around and over the pot, the lobster always backs in, primarily that he may be prepared to meet any foe following him, also because his large claws would be apt to catch in the net funnel should he enter head first. After discovering that he is imprisoned, which he does very speedily, he seems to lose all desire for the bait, and spends his time roaming around the pot hunting for a means of escape.

The pots are generally hauled once a day, but sometimes twice a day in good weather. As the tide along the Maine coast is quite strong, the fishermen usually haul their pots at or about slack water, low tide generally being preferred when they are worked once a day. The number used by a fisherman varies greatly on different sections of the coast. According to the investigations of this Commission, the average number of pots to the man in certain years was as follows: Fifty-six pots in 1880, 59 in 1887 and 1888, 58 in 1889 and 1892, and 50 in 1898. This average, however, is somewhat misleading, as quite a number of persons along the coast take up lobstering for only a few months in the year, and then return to their regular occupations. As these persons use but few pots, the average per man throughout the whole State is very considerably reduced. The regular lobster fishermen have been steadily increasing the number of their pots for several years past. They have found this an absolute necessity in order to catch as many lobsters now as they caught twenty or thirty years ago. It is not unusual now to find one of the regular fishermen handling as high as 100 pots, and sometimes even 125, when a few years ago 25 and 50 pots was a large number. This does not take into account his reserve stock of pots, which it is necessary to have on hand in order to replace those damaged or lost.

BAIT.

Cod, hake, and halibut heads are quite generally used as bait. Halibut heads are said to be the best, as they are tougher than the cod or hake heads, and thus last much longer. Sculpins, flounders, in fact almost any kind of fish, can be used. In the vicinity of sardine canneries the heads of herring are used. Sometimes the bait is slightly salted, at other times it is used fresh. Small herring are lightly salted, and then allowed to remain until partly decayed, when they are inclosed in small bags, and these put into the pots. The oil from this bait forms a "slick" in the water, and when the smell from it is strong the fishermen consider it at its best. The bait is generally secured by small haul-seines and spears in sections where offal can not be bought.

FISHING VESSELS AND BOATS.

The fishing vessels are either sloop or schooner rigged, with an average net tonnage of slightly over 8 tons (new measurement) and an average value of about $475. There has been a great increase in the number of these vessels during recent years. Eight vessels were used in 1880, 29 in 1889, and 130 in 1898. Quite a number of these vessels are used in other fisheries during their seasons. Two men usually form a crew, although three, and sometimes four, are occasionally used.

The other vessels comprise sailboats under 5 tons and rowboats. The sailboats are generally small square-sterned sloops, open in the afterpart, but with a cuddy forward. They are all built with centerboards, and some are lapstreak while others are "set work." Around the afterpart of the standing room is a seat, the ballast is floored over, and two little bunks and a stove generally help to furnish the cuddy. They vary in length from 16 to 26 feet and in width from 6 to 9 feet; they average about 2 tons. They are especially adapted to the winter fishery, as they are good sailers and ride out the storms easily.

Dories are in quite general use in the lobster fishery, as are also the double-enders, or peapods. This latter is a small canoe-shaped boat of an average length of 15½ feet, 4½ feet breadth, and 1½ feet depth. They are mainly built lapstreak, but a few are "set work." Both ends are exactly alike; the sides are rounded and the bottom is flat, being, however, only 4 or 5 inches wide in the center and tapering toward each end, at the same time bending slightly upward, so as to make the boat shallower at the ends than in the middle. This kind of bottom is called a "rocker bottom." They are usually rowed, but are sometimes furnished with a sprit sail and centerboard.

TRANSPORTING VESSELS OR SMACKS.

Even before the lobster fishery had been taken up to any extent, the coast of Maine was visited by well-smacks from Connecticut and New York, most of which had been engaged in the transportation of live fish before engaging in the carrying of lobsters. These vessels sometimes carried pots, and caught their own lobsters; but as this method was not very convenient, the people living along the coast took up the fishery, and sold the lobsters to the smackmen. About 1860 the canneries began to absorb a considerable part of the catch, and they employed vessels to ply along the coast and buy lobsters. As these vessels would only be out a few days at a time, wells were not necessary, and the lobsters were packed in the hold. In the summer great numbers of them were killed by the heat in the hold. After 1885 the canneries rapidly dropped out of the business, the last one closing in 1895. In 1853 there were but 6 smacks, 4 of them from New London, Conn. In 1880 there were 58, of which 21 were dry smacks, while in 1898 there were 76, of which 17 were steamers and launches and 59 sailing vessels. These were all well-smacks. A few sailing smacks also engaged in other fishery pursuits during the dull summer months. In 1879 a steamer which had no well was used to run lobsters to the cannery at Castine. The first steamer fitted with a well to engage in the business was the *Grace Morgan*, owned by Mr. F. W. Collins, a lobster dealer of Rockland, who describes the steamer as follows:

The steam and well smack *Grace Morgan* was built in 1890, by Robert Palmer & Son, of Noank, Conn. At that time she was a dry boat, but the following year, 1891, the Palmers built a small well in her as an experiment, but I am of the opinion that it did not prove very satisfactory or profit-

able; consequently they offered her for sale and wrote to me in relation to buying her. I went to Noank and looked her over and came to the conclusion that by enlarging the well and making other needed changes she could be made not only a good boat to carry lobsters alive, but also to do it profitably; consequently I bought her and brought her to Rockland, had the well enlarged on ideas of my own, and differently constructed, so as to give it better circulation of water, and also made other needed improvements throughout the boat to adapt her especially for carrying lobsters alive. The changes I made in her proved so successful in keeping lobsters alive, while it increased the capacity for carrying, that I have since adapted the same principles on all my boats. The well I had put into the *Grace Morgan* is what is termed a "box well," that is, without any well deck. The well is built from the sides of the steamer directly to the hatch on the main deck, with bulkheads forward and aft and tops running directly to the deck. * * * You will see at once that this well has many advantages over the old style with flat well decks, like those of sailing vessels: (1) It affords a much larger carrying capacity in same space of vessel. (2) The priming-out pieces are much higher up on sides of vessel, giving more room for boring hull, which affords much better circulation of water in well, which is a great advantage in keeping lobsters alive while on long trips. (3) Every lobster can be easily bailed out of the well without grounding the vessel, which is necessary with all vessels having the old-style well. (4) In all steam and well smacks the after part of the ship is always steadiest, consequently the well being located aft, as in my smacks, the lobsters contained in them are not subjected to the hard pounding while running in seaway that they are in the old-style wells, where there is no chance to relieve themselves other than to be forced against the well decks by the upward force of the water when the vessel settles into the sea, and which results in killing many of them.

Both of my steamers have box wells aft, and from my experience, compared with all other steam and well smacks afloat, I am convinced that this well, for all practical purposes, is the best that has yet been adapted to steam smacks. So far as the *Grace Morgan* is concerned, she has been a perfect success in carrying her lobsters in all kinds of weather since I put her into commission October 27, 1892, during which time she has had a wonderful career, as well as carrying millions of lobsters. Probably no boat of her size has ever had such an experience, as she has run steadily the year around in all kinds of weather during the past eight years. * * * Previous to buying the *Grace Morgan* I had run steamers in the lobster business, but they had no well, and being so hot in their holds, particularly in the summer months, the lobsters died so fast that the business in dry steamers could not be made profitable. This is what prompted me to construct a well in mine, as I have done.

The *Grace Morgan* has a length of 49 feet, a breadth of 13.9 feet, and a depth of 5.7 feet, a gross tonnage of 21 tons, and a net tonnage of 10 tons.

The steam smacks now used average about 14 tons. They are usually built low in the water, and have a small pilot-house forward, with an open space between it and the engine-house, and living quarters aft. The boat has also one or two short masts. Some of them also have the pilot-house and engine-house joined together. In those with a space between the pilot-house and engine-house the well is usually placed in this open space. Where the pilot-house and engine-house are together the well is either located forward or aft. These wells are generally capable of holding from 3,000 to 10,000 live lobsters. Small holes in the bottom of the well keep it filled with fresh sea water. Should the weather be clear the proportion of dead and injured lobsters will be small, but in bad weather many are apt to be killed by the pitching and rolling to which they are subjected.

These smacks make regular trips up and down the coast, landing their cargoes either at Rockland, Portland, or at one of the lobster pounds scattered along the coast. They not only stop at the villages, but also drop anchor off the little camps of the lobstermen, and should the smacks of two rival dealers arrive at a place simultaneously, which frequently happens, the bidding between the captains for the fishermen's catch gladdens the latter's heart and greatly enriches his pocketbook. Most of the captains have regular places of call where they know the fishermen are holding their lobsters for them, and they follow a rude sort of schedule, which will not often vary more than a day or two. The lobsters are bought of the fishermen

by count, and cash is paid for them. Should the smack belong to a dealer this practically ends the financial side of the transaction so far as the captain is concerned, as the crew are paid wages. Should the smack belong to a person other than a dealer, which is frequently the case, he either makes an agrement with some dealer to run for him exclusively at a certain price or commission, or else buys from the fishermen and then sells at either Rockland or Portland. This method of buying lobsters is somewhat hazardous, as the market price sometimes changes sharply when the smack is out of reach of telegraphic communication.

LOBSTER CARS.

Lobsters must be marketed in a live or boiled condition; and as fishermen can get better prices for them alive than boiled, each fisherman generally has a live-car in which to hold them until they can be sold. These cars are usually oblong, rectangular boxes, with open seams or numerous small holes to permit the free circulation of the water. They are of various sizes, according to the needs of the fisherman, a good average being about 6 feet long by 4 feet wide and about 2 feet deep. The door is placed on the top. They are usually moored close to the shore during the fishing season, the rest of the time being hauled up on the beach.

The dealers' cars are very similar to those used by the fishermen, only much larger. They generally average about 30 feet in length, 12 feet in width, and 3 feet in depth, with capacity for from 2,000 to 3,000 lobsters. The inner part of this car is usually divided off into five transverse compartments by means of a framework inside. Each compartment is provided with two large doors entering from the top, one door on each side of the middle line of the car. These cars cost the dealers about $70 each. The life of one of these cars is about five or six years, although at the end of about three years it is generally necessary to replace the sides of the car on account of the ravages of a dock worm which is quite abundant along the Maine coast. When new the top of the car is usually about a foot above the water, but as it gets water-soaked it sinks down until it is even with the water, and some of the older cars have to be buoyed up with kegs at each end, placed inside, to prevent them from sinking below the surface. These cars are moored alongside the docks of the dealers at Portland and Rockland and other points.

Mr. J. R. Burns, of Friendship, has invented and patented a new style of car. The inside is divided into a series of compartments by horizontal and vertical partitions of slats, wire netting, or any material which will permit the free circulation of the water. Each compartment has a chute extending down into it from the top, by means of which the lobsters can be put in and their food given them. There are also conveniently arranged openings, with doors, through which the lobsters may be removed when desired. These cars usually average about 35 feet in length, 18 feet in width, and 6 feet in depth, and have a capacity for about 5,000 lobsters each. They are in use at Rockland, Friendship, Tremont, and Jonesport. They prevent the lobsters from huddling together and thus killing each other by their own weight.

METHODS OF SHIPPING, WHOLESALE TRADE, ETC.

As lobsters can not be shipped or preserved in a frozen state they must be shipped either alive or boiled. About nine-tenths of the lobsters caught in Maine waters are shipped in the live state. The principal shipping centers are Portland, Rockland, and

FISHERMEN OPERATING THEIR POTS.

INCLOSURE FOR LIVE LOBSTERS AT VINAL HAVEN, MAINE.

Eastport, which have good railroad and steamship facilities with points outside of the State. Those shipped from the latter point are mainly from the British Provinces, the fishermen near Eastport bringing them in in their own boats. A number also come in from the Provinces on the regular steamship lines. The other places get their supply from the smacks and also from the fishermen in their vicinity, who run in their own catch. Portland is very favorably situated in this regard, as Casco Bay is a noted fishing center for lobsters.

As soon as a smack arrives it is moored directly alongside one of the cars. The lobsters are then dipped out of the well by means of long-handled scoop nets and thrown on the deck of the vessel. The doors of the car are then opened, and men on the vessel pick over the lobsters lying on the deck and toss them two by two into the different compartments, those dead and badly mutilated being thrown to one side for the time being. All vigorous lobsters above a certain size are placed in compartments of the car by themselves, while the weak and small are put in separate compartments. The dead lobsters and those which have had their shells broken or have been so injured that they are very sure to die are either thrown overboard or on the dump. A lobster which has lost one or even both claws is not thrown away, as such an injury would have very little effect on its health.

When an order is received for live lobsters, those which have been longest in the cars are usually shipped. Flour barrels holding about 140 pounds or sugar barrels holding about 185 pounds, with small holes bored in the bottoms for drainage, are used for the shipment. Formerly the lobsters were packed close together in the barrel, and a large piece of ice was put in at the top, but this was found to kill a number of them. The present method is to split off about one-third of a 100-pound cake of ice the long way, and place it upright about half way of the length of the barrel, the lobsters then being packed snugly on all sides of the ice. In handling them the packer seizes the lobster by the carapax with his right hand, bends the tail up under the body with his left hand, and quickly deposits it in the barrel. The packer usually has his right hand covered with a woolen mit or wrapped in a long piece of linen, for protection from the claws of the lobster.

When the barrel is nearly full the lobsters are covered with a little seaweed or large-leaved marine plants, and the rest of the space is filled with cracked ice. The top is then covered with a piece of sacking, which is secured under the upper hoop of the barrel. Packed in this way, lobsters have easily survived a trip as far west as St. Louis.

Owing to the high prices realized in England for live lobsters, attempts have been made to ship live American lobsters to that market, generally from Canadian ports. In 1877 Messrs. John Marston & Sons, of Portland, made a trial shipment of 250. They were placed in a large tank 20 feet long by 8 feet wide and 3 feet deep, and constantly supplied with fresh seawater through six faucets by means of a donkey engine, a waste-pipe preventing any overflow. The trip was fairly successful, as only 50 died, and the balance brought from 60 to 75 cents per pound.

The smacks and dealers buy lobsters by count, as the fishermen generally have no facilities for weighing them; but the dealers always sell by weight. The mortality among the lobsters from the time they are put aboard the smacks until they are barreled for shipment is estimated at about 5 per cent.

BOILING.

Live lobsters are much preferred by the trade throughout the country, and only those that can not be marketed in such condition are boiled. The number boiled fluctuates considerably, owing to the condition of the markets. When the fresh markets of Boston and New York are overstocked, the lobster dealers of Rockland and Portland, where most of the Maine lobsters are boiled, proceed to boil their surplus stock.

The following description of the boiling is from The Fisheries and Fishery Industries of the United States, section V, vol. II, p. 684:

> The boilers are rectangular wooden tanks or vats of about 60 gallons capacity, lined with zinc and furnished with a cover. Heat is applied by the introduction of steam through a series of perforated pipes arranged in the bottom of the tank. The steam is generated in an ordinary boiler standing close at hand. The lobsters are not thrown directly into the vat, as the operation of removing them after cooking would in such an event be an exceedingly tedious one; but an iron framework basket of rather slender bars is made to fit the tank loosely, and is lowered and raised by means of a small derrick placed over the tank. This frame, which holds about 350 pounds, is filled with lobsters at the edge of the wharf from the floating cars, and is then carried to the tank and lowered into it after the water it contains has reached the desired temperature, that of boiling. The water is first supplied to the tank, which is filled to about one-third or two-thirds its capacity, about a peck of salt is added, and then the steam is turned on. The same water suffices for several successive boilings, about 2 quarts of salt being added each time. The lobsters are allowed to remain in about half an hour, or until the proper red color indicates they are sufficiently cooked.

After cooling, they are packed in barrels for shipment, just as live lobsters are. When well iced they will keep a week or longer. Only live lobsters are boiled, as the meat of those which die prior to boiling deteriorates rapidly.

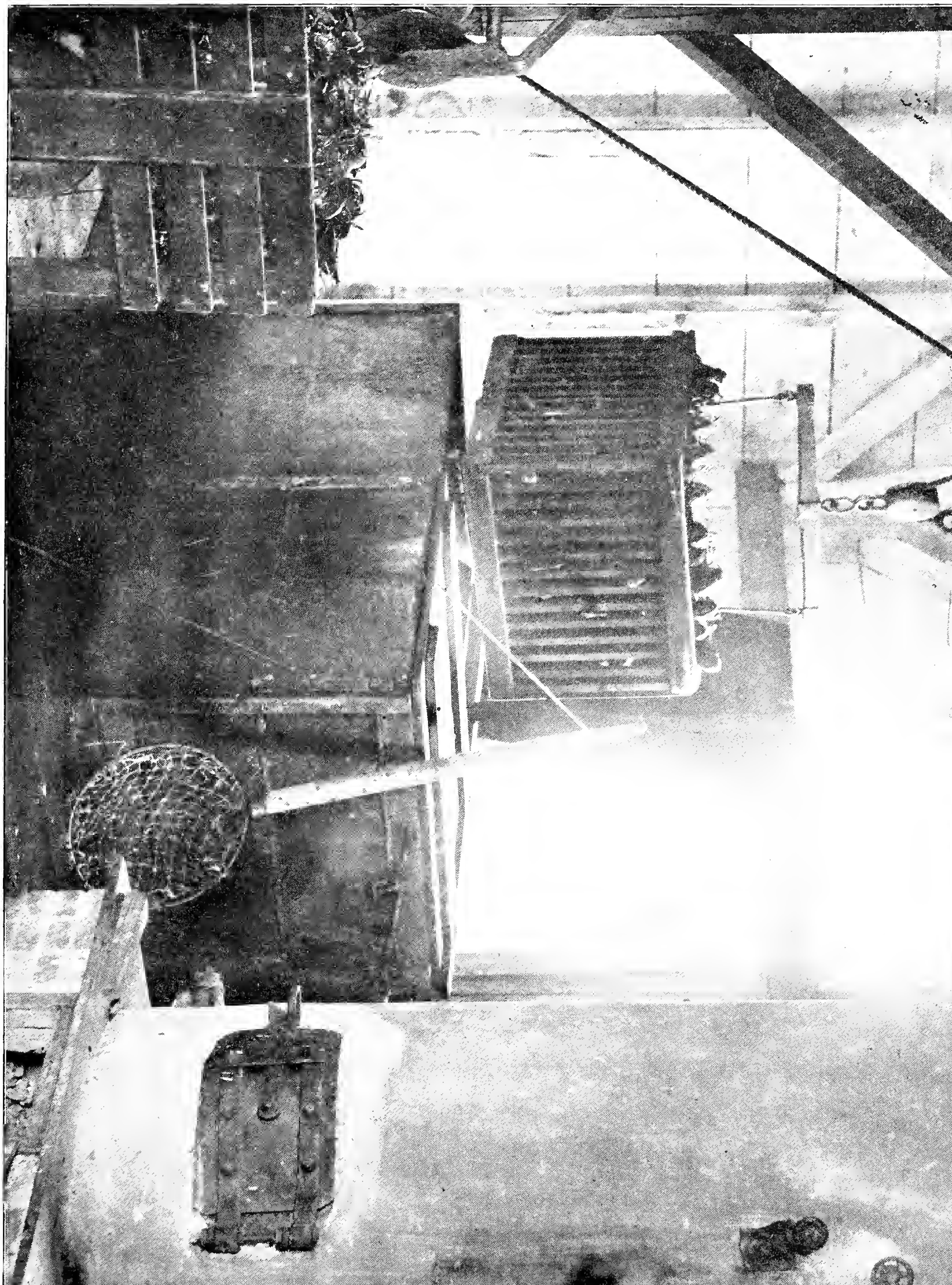
The fishermen and small dealers use various kinds of boilers, from an ordinary washboiler to a smaller form of the regular boiler used by the large dealers. The product prepared by these people is generally picked from the shell and sold locally in that condition. This opens a way for the fisherman to evade the 10½-inch limit law. They frequently take lobsters under the minimum legal size and, after boiling them, pick the flesh. It is then impossible for anybody to tell what sized lobster the meat had come from. Quite a local trade in the picking of lobsters has been established in a number of small coast towns, the meat generally being sold in the immediate vicinity.

The following table shows the extent of the wholesale lobster trade in Rockland and Portland during 1898, including everything connected with the business except the smacks and pounds, which are shown elsewhere. There are a few other dealers scattered along the coast, but most of the business is concentrated at these cities. An idea of the extent of the increase in the lobster trade of Portland can be gained when it is stated that in 1880 about 1,900,000 pounds of lobsters, valued at $70,000, were handled here, while 6,145,821 pounds, valued at $611,955, were handled in 1898.

Extent of the wholesale lobster trade of Rockland and Portland in 1898.

Value of property, capital, and wages.	Rockland.	Portland.	Number of persons engaged.	Rockland.	Portland.	Lobsters bought and sold.	Rockland.		Portland.	
							No.	Value.	No.	Value.
Property, etc.	$14,338	$44,770	Firms	2	*10	Bought ..... No.	692,188	....	4,097,214	....
Cars	850	6,800	Proprietors	3	13	Bought ..... lbs.	1,038,282	$89,984	6,145,821	$611,955
Cash capital	22,000	110,500	Clerks	2	2	Sold, alive .. lbs.	795,934	91,532	5,308,027	690,045
Wages	4,676	18,198	Other employees	7	31	Sold, boiled . lbs.	347,815	26,705	515,518	82,483

* Several of these firms also handle other fishery products.



BOILING LIVE LOBSTERS PREPARATORY TO SHIPPING IN ICE, SHOWING BOILER, STEAM TANK, CAGE, ETC.

LOBSTER POUNDS.

For a number of years the catch of lobsters was sold by the fishermen to the dealers and by the latter to the trade as rapidly as possible. In doing this the markets would be flooded at certain times, when the price would drop to a very low figure, while at other times they would be very scarce, which would enhance the price materially. The dealers were the first to see the necessity for devising some method by which lobsters could be secured when they were plentiful and cheap and retained in captivity until they became scarce and high in price. Inclosures of various kinds had for some years been in use in the fisheries in various parts of the country for the purpose of keeping certain species alive until the time came to utilize them. In 1875 Johnson & Young, of Boston, established an inclosure or pound near Vinal Haven, on one of the Fox Islands. A cove covering about 500 acres, with an average depth of about 90 feet, was selected. A section of about 9 acres, separated from the main portion of the cove by a natural shoal and with a bottom of soft grayish mud, was selected for the pound. In order to make it proof against the efforts of the lobsters to escape and as a protection from enemies without, a wire fence was built over the shoal part. This section had a depth of from 15 to 60 feet, and a capacity of about 300,000, although there were rarely that many in the pound at one time.

The lobsters are bought from smacks and from fishermen in the vicinity during the height of the fishing season, when the price is low, and are retained in the pound until the price becomes high, which is generally during the winter season. They are fed with fish offal, which can usually be bought at Vinal Haven for $1 per barrel. Oily fish are not fed to them, as it is said that the lobsters decrease in weight on such a diet. Experience has shown that the quantity of food required depends largely on the temperature of the water, as lobsters do not eat as freely when the water is cold as in water of a higher temperature. When wanted for shipment they are usually secured by means of pots, seines, or beam trawls.

Even with such a successful example before them, other dealers were chary about going into the business, and in 1890 there were only three pounds in the whole State. They increased more rapidly after that, however, and in 1898 there were nine pounds in the State, with a total valuation of $18,700. These were located at Dyer Bay, Sunset, Vinal Haven, Long Island, South Bristol, Pemaquid Beach, Southport, and House Island, in Portland Harbor. It is very probable that there will be a greater increase in the near future.

THE CANNING INDUSTRY.

Maine is the only State in the Union in which lobsters have been canned. The following account of the inception and early history of the industry, taken from "The Fisheries and Fishery Industries of the United States," is very complete:

> Lobster canning was first attempted in the United States at Eastport, Me., shortly after 1840, and was made successful in 1843, the methods finally employed having been borrowed from Scotland, which country is said to have learned the process from France. For the successful introduction of the process into the United States we are indebted to Mr. Charles Mitchell, now of Charlestown, Mass., a practical canner of Scotland, who had learned his trade of John Moir & Son, of Aberdeen, the first Scotch firm, it is claimed, to put up hermetically sealed preparations of meat, game, and salmon, their enterprise dating back to 1824. Mr. U. S. Treat, a native of Maine, appears, however, to have been most active and influential in starting the enterprise and in introducing canned goods into the markets of the United States. Mr. Treat was, at an early period, engaged in the preparation

of smoked salmon on the Penobscot River, and in 1839 removed to Calais, Me., where he continued in the same business. About 1840 he associated with him a Mr. Noble, of Calais, and a Mr. Holliday, a native of Scotland, who had also been employed in the salmon fisheries of the Penobscot River, under the firm name of Treat, Noble & Holliday. This firm moved to Eastport in 1842, for the purpose of starting the manufacture of hermetically sealed goods, and began experiments with lobsters, salmon, and haddock. Their capital was limited, their appliances crude, and many discouraging difficulties were encountered. The quality of the cans furnished them was poor, causing them often to burst while in the bath, and the proper methods of bathing and of expelling the air from the cans were not understood. The experiments were continued for two years with varying success, and in secret, no outsiders being allowed to enter their bathing room. Though fairly successful in some of their results, they could not always depend upon their goods keeping well.

In 1843 they secured the services of Mr. Charles Mitchell, who was then residing at Halifax, and who was not only well acquainted with the methods of bathing practiced in his own country, but was also a practical tinsmith. He had been employed in the canning of hermetically sealed goods in Scotland for ten years, and came over to Halifax in 1841, where he continued for two years in the same occupation, exporting his goods to England. After Mr. Mitchell's arrival at Eastport, no further difficulty was experienced in the bathing or other preparation of the lobsters, and a desirable grade of goods was put up, but they found no sale, as canned preparations were comparatively unknown in the markets of the United States. Mr. Treat visited each of the larger cities with samples of the goods, and endeavored to establish agencies for them, but he was generally obliged to send on consignment, as few firms were willing to take the responsibility of buying on their own account. A patent was also applied for, but the claim was not pressed and the patent was never received.

The success at Eastport led to a rapid extension of the business in other parts of the State. The second cannery was located at Harpswell about the year 1849. A cannery was started at Carver Harbor, Fox Islands, in 1851, and another at Southwest Harbor in 1853. In 1857 a cannery was started at North Haven, and at Gouldsboro two were started in 1863 and 1870, respectively. From this time the number increased rapidly for several years. After 1880 the number operated fluctuated considerably, depending on the abundance of lobsters. Some canneries had to suspend operations at an early stage, owing to the exhaustion of the grounds in their vicinity. At most canneries lobsters formed only a part of the pack, sardines, clams, fish, and various vegetables and fruits being packed in their season. Most of the canneries were built and operated by Boston and Portland firms.

At first the lobsters used for canning ranged in weight from 3 to 10 pounds. Gradually the average weight was reduced, until at last it reached as low as $\frac{3}{4}$ pound, or even less. This was caused principally by the high prices paid for large lobsters for the fresh trade, with which the canneries could not compete.

As the supply of lobsters on the Maine coast began to decrease shortly before 1870, while the demand for canned lobsters increased at an enormous rate, the dealers began to establish canneries on the coasts of the British provinces. As the decline in the supply was attributed to the canneries, a sentiment against them was gradually formed, and laws were enacted regulating the time in which they could operate and the size of the lobsters they could put up. Prior to 1879 they were permitted to pack lobsters at any season of the year, but they usually operated only between April 1 and August 1, and again between the 10th or middle of September and the 1st of December, the length of the season depending very largely upon the weather and the abundance of lobsters. In 1879 it was enacted that no canning of lobsters should be allowed from August 1 to April 1 following. In 1883 it was made illegal to can lobsters less than 9 inches in length. In 1885 the canning season was fixed from April 1 to July 15. In 1889 the season was fixed from May 1 to July 1, and the minimum length of lobsters to be canned placed at 9 inches. In 1891 this act was so

amended as to make the season from April 20 to June 1. After 1880 the number of canneries gradually declined, until in 1895 the last one suspended the canning of lobsters, owing to the passage of a law fixing the minimum size at 10½ inches. This law went into effect July 1, 1895. As they could not afford to pay the high price demanded for this size they were compelled to give up the business.

The following table shows the number of factories in operation, the quantity and value of fresh lobsters used, and the number and value of cans of lobsters put up, in the years 1880, 1889, and 1892:

	1880.		1889.		1892.	
	No.	Value.	No.	Value.	No.	Value.
Number of canneries	23		20		11	
Lobsters used, fresh ..lbs	9,494,284	$95,000	5,752,654	$72,092	5,326,322	$78,720
Canned:						
One-pound cans	1,542,696		999,521	126,577	1,228,944	195,114
Two-pound cans	148,704		85,520	16,036	3,096	839
Other sizes	139,801					
Total cans	1,831,201	238,280	1,085,041	142,613	1,232,040	195,953

Part of the lobsters used in the Eastport factories come from New Brunswick. It is impossible to separate them.

ABUNDANCE, ETC.

There are no accurate figures showing the catch of lobsters in Maine previous to 1880. It is therefore difficult to make comparisons, and one is compelled to depend largely upon the memory of the fishermen and the statements of the canners and dealers, which the lapse of time, etc., makes rather unreliable. The numerous petitions sent to the legislature asking for restrictive laws, while possibly exaggerated at times, indicate that there were fears of the exhaustion of the fishery for some years back. It is positively known, however, that certain grounds have been almost or totally exhausted through overfishing for a number of years, while on other grounds the supply of lobsters has seriously decreased. There was a time when no lobster under 2 pounds in weight was saved by the fishermen. In later years, before there was a restriction fixing the minimum size of lobsters that could be canned, the canneries frequently used half-pound lobsters. The fixing of the minimum length of the lobsters caught at 10½ inches, and the consequent closing up of the canneries, has been of incalculable benefit to the fishermen, as the young lobsters now have an opportunity to reach maturity.

The table given below shows for certain years the number of pots used, the quantity of lobsters taken, with their value, also the average catch and value per man, the average catch per pot, and the average price per pound:

Year.	Fishermen.	Pots.	Catch.		Average catch per man.	Average stock per man.	Average catch per pot.	Average price per pound.
			Pounds.	Value.				
					Pounds.		*Pounds.*	*Cents.*
1880	1,843	104,456	14,234,182	$268,739	7,723	$146	136	1.9
1887	1,906	113,299	22,916,642	512,044	12,023	269	202	2.2
1888	1,967	112,632	21,694,731	515,880	11,029	267	193	2.4
1889	2,080	121,140	25,001,351	574,165	12,020	276	206	2.3
1892	2,628	153,043	17,642,677	663,043	6,713	252	117	3.8
1898	3,099	155,978	11,183,294	992,855	3,609	320	78	8.9

While the catch increased up to 1889 and then decreased until in 1898 it was lower than in 1880, the number of fisherman and pots and the value of the catch steadily increased. The average stock per man fluctuated somewhat from year to year, but in 1898 shows a considerable increase over every other year. The most interesting point, however, is the average price per pound. In 1880 this was 1.9 cents, while in 1898 it was 8.9 cents per pound. With one exception, each year shows a progressive increase in value per pound. The great increase of 1898 over 1892, 5.1 cents per pound, was caused by the closing up of the canneries in 1895, and the consequent dropping out of the cheap product they had been buying from the fishermen.

WEIGHT OF LOBSTERS.

The figures given below show the average weight of lobsters at certain given lengths. These weights are made up from the results obtained by investigators of the United States Fish Commission, particularly those of Prof. Francis H. Herrick. Males in nearly every instance weigh slightly more than females of the same length.

Length.	Weight in pounds.
9 inches	1.16
10 inches	1.50
10½ inches	1.75
11 inches	2
12 inches	2.50
13 inches	2.75
15 inches	4.25

CHEMICAL COMPOSITION OF LOBSTERS.

The nutritive value of a fishery product is of considerable interest to the consumer. Some years ago, Prof. W. O. Atwater, of Middletown, Connecticut, made a series of careful analyses of the composition of the flesh of three lobsters from the coasts of Maine and Massachusetts, and the figures given below represent the results:

Proportions of edible portion and shell:	Per cent.
Total edible portion	39.77
Shell	57.47
Loss in cleaning	2.76
Proportions of water and dry substance in edible portion:	
Water	82.73
Dry substance	17.27
Chemical analysis calculated on dry substance:	
Nitrogen	12.54
Albuminoids (nitrogen × 6.25)	78.37
Fat	11.43
Crude ash	10.06
Phosphorus (calculated as P_2O_5)	2.24
Sulphur (calculated as SO_3)	2.47
Chlorine	3.46
Chemical analysis calculated on fresh substance in flesh:	
Water	82.73
Nitrogen	2.17
Albuminoids (nitrogen × 6.25)	13.57
Fat	1.97
Crude ash	1.74
Phosphorus (calculated as P_2O_5)	.39
Sulphur (calculated as SO_3)	.43
Chlorine	.59
Nutritive value of flesh of lobsters compared with beef as a standard and reckoned at 100	61.97

ARTIFICIAL PROPAGATION OF THE LOBSTER.

The rapid increase in the catch of this crustacean during the past ten years has drawn upon it the most earnest attention of all interested in the preservation of this valuable fishery. If the "berried" or female lobster bearing eggs, and the young and immature, were let alone by the fishermen there would be no necessity for a resort to artificial lobster culture. Maine has a most stringent law forbidding the taking and selling of "berried" lobsters, and of any lobster under 10½ inches in length, but this law is evaded by numerous fishermen whenever possible. An idea of the extent to which short lobsters are marketed in the State may be gathered from the statement of Mr. A. R. Nickerson, commissioner of sea and shore fisheries for the State, that in 1899 over 50,000 short lobsters were seized and liberated by the State wardens. As these wardens only discover a small proportion of the short lobsters handled by the fishermen and dealers it is easy to see what a terrible drain this is on the future hope of the fishery—the young and immature. Large numbers of "berried" lobsters are also captured, the eggs brushed off, and the lobsters sold as ordinary female lobsters.

The Report of the U. S. Fish Commission for 1897, on pages 235 and 236, contains the following account of the artificial propagation of lobsters:

Prior to 1885 experiments had been conducted at various points looking to the artificial propagation of the lobster. The only practical attempts of this nature previous to those made by the Fish Commission were by means of "parking," that is, holding in large naturally inclosed basins lobsters that had been injured, soft-shelled ones, and those below marketable size. Occasionally females with spawn were placed in the same inclosures. One of these parks was established in Massachusetts in 1872, but was afterwards abandoned; another was established on the coast of Maine about 1875. It was soon demonstrated, however, that the results from inclosures of this character, so far as the rearing of the lobsters from the young were concerned, would not be sufficient to materially affect the general supply. The completion of the new marine laboratory and hatchery at Woods Hole in 1885, with its complete system of salt-water circulation, permitted the commencement of experiments in artificial hatching on a large scale which had not been practicable theretofore, although small quantities of lobster eggs, as well as those of other crustaceans, had been successfully hatched. In 1886 the experiments had progressed so successfully that several million eggs were collected and hatched at Woods Hole, the fry being deposited in Vineyard Sound and adjacent waters. From 1887 to 1890, inclusive, the number of eggs collected was 17,821,000.

During the above years the average production of fry was about 54 per cent. By the use of more improved apparatus the average was brought up to 90 per cent in 1897, when the collections amounted to 150,000,000 eggs, of which 135,000,000 were hatched. As the commissioner of sea and shore fisheries of Maine objected to the taking of female lobsters in that State and the planting of part, at least, of the resulting fry in other waters, an arrangement was made in 1898 by which all female lobsters and the fry hatched out from the eggs secured from these would be returned to the State waters. Under this arrangement 2,365 "berried" lobsters were bought from the Maine fishermen by the U. S. Fish Commission. From these 25,207,000 eggs were taken and 22,875,000 fry were hatched. Of these, 21,500,000 were deposited in Maine waters at various points. In 1899, 36,925,000 fry were planted in Maine waters by the Commission. In order that the female lobsters may be secured the authorities of Maine permit the fishermen to catch and sell "berried" lobsters to the Commission.

The collection of eggs in Maine is usually made by the Commission during the months of April, May, June, and to about the middle of July, depending upon the supply to be had. During the season of 1899 a small steam smack was chartered for collecting the lobsters, starting from Gloucester, where the hatching of Maine lobster

eggs is now carried on, and running to Eastport, returning over the same route. The Fish Commission schooner *Grampus* was also used in this work. The lobsters are purchased from fishermen, who receive the market price for ordinary lobsters, and as they are not allowed to sell these lobsters legally for consumption the sale to the Commission materially increases their financial returns.

In 1883 a radical advance along the line of artificial propagation was made, so far as the legislature was concerned, when the act incorporating the Samoset Island Association, of Boothbay, was passed. Section 4 of the charter reads as follows:

> In order to secure a sufficient and regular supply of lobsters for domestic consumption on any land or islands under the control of said corporation, it may increase the number of lobsters within said limits by artificial propagation, or other appropriate acts and methods, under the direction of the fishery commission, and shall not be interfered with by other parties, but be protected therein, as said fishery commission may determine, and shall have the right, by its agents and tenants, to take and catch lobsters within 300 yards of the low-water line of the islands and lands owned or leased by said corporation, during each and every month, for domestic use.

In 1887 the legislature passed an act granting R. T. Carver the sole right to propagate lobsters in Carver's pond, in Vinal Haven. Mr. Carver's experiment was a failure, as he says the mud in the pond was so filthy that nearly all the spawn was killed.

LARGE AND PECULIAR LOBSTERS.

Since the inception of the fishery, stories of the capture of lobsters weighing 30, 40, and even 50 pounds have been common, but have rarely been well authenticated. Especially is this the case in the early years of the fishery. It is probable that in the transmission of the stories from person to person the lobsters gained rather than lost in size. Among the most authentic cases in Maine are the following:

On May 6, 1891, a male lobster weighing slightly over 23 pounds was taken in Penobscot Bay, southeast of Moose Point, in line with Brigadier Island, in about 3½ fathoms of water, by Mr. John Condon. The lobster had tried to back into the trap, but after getting his tail through the funnel he was unable to get either in or out and was thus captured.

According to Mr. F. W. Collins, a dealer of Rockland, in August, 1891, a lobster weighing 18½ pounds was taken at Blue Hill Falls, in upper Blue Hill Bay, while in November, 1892, a female lobster weighing 18 pounds was taken at Green Island.

In January, 1893, Mr. N. F. Trefethen, of Portland, received a lobster from Vinal Haven which weighed 18 pounds.

According to R. F. Crie & Sons, of Criehaven, on September 7, 1898, a male lobster weighing 25 pounds and measuring 25 inches from the end of the nose to the tip of tail, and 45 inches including the claws, was caught on a hake trawl by Peter Mitchell, a fisherman. The trawl was set about 2 miles southeast from Matinicus Rock Light Station in 60 fathoms of water.

In August, 1899, the writer saw a live male lobster at Peak Island which measured 44 inches in length and weighed 25 pounds, according to the statement of the owner. It had been caught near Monhegan Island, and the owner was carrying it from town to town in a small car, which he had built for it, and charging a small fee to look at it.

In April, 1874, a female lobster weighing about 2 pounds was caught off Hurricane Island. Her color was a rich indigo along the middle of the upper part of the body, shading off into a brighter and clearer tint on the sides and extremities. The

upper surface of the large claws was blue and purple, faintly mottled with darker shades, while underneath was a delicate cream tint. The under parts of the body tended also to melt into a light cream color, and this was also true of the spines and tubercles of the shell and appendages.

In 1892 a Peak Island fisherman caught a lobster about 11 inches in length whose back was of an indigo blue, and which toward the extremities and under parts was shaded off into a pure white. The under part of the claw was also of a pure white.

Mr. Lewis McDonald, of Portland, has a pure white lobster preserved in alcohol. It was caught in 1887.

A lobster was caught at Beal Island, near West Jonesport, which was about 6 or 7 inches in length and almost jet black.

A few bright-red lobsters, looking as though they had been boiled, have also been taken along the coast at various times.

A lobster was caught near Long Island, Casco Bay, about the year 1886, in which half of the body was light-yellow up to the middle line of the back, while the other half was bright-red. There were no spots on the shell.

In September, 1898, Mr. R. T. Carver, of Vinal Haven, had in his possession a female lobster, about 11 inches long, of a bright-red color all over, except the forward half of the right side of the carapace and the feeler on this side, which were of the usual color.

LAWS REGULATING THE FISHERY.

In 1897 the legislature revised and consolidated the laws relating to the sea and shore fisheries of Maine, and below are given the sections relating to the lobster fishery adopted that year, together with the amendments to the act adopted in 1899, which are incorporated herewith:

SEC. 39. It is unlawful to catch, buy or sell, or expose for sale, or possess for any purpose, any lobsters less than 10½ inches in length, alive or dead, cooked or uncooked, measured in manner as follows: Taking the length of the back of the lobster, measured from the bone of the nose to the end of the bone of the middle of the flipper of the tail, the length to be taken in a gauge with a cleat upon each end of the same, measuring 10½ inches between said cleats, with the lobster laid upon its back and extended upon its back upon the gauge, without stretching or pulling, to the end of the bone of the middle flipper of the tail, its natural length, and any lobster shorter than the prescribed length when caught, shall be liberated alive at the risk and cost of the parties taking them, under a penalty of $1 for each lobster so caught, bought, sold, exposed for sale, or in the possession not so liberated. The possession of mutilated, uncooked lobsters shall be prima facie evidence that they are not of the required length.

SEC. 40. It is unlawful to destroy, buy, sell, expose for sale, or possess any female lobsters in spawn or with eggs attached at any season of the year, under a penalty of $10 for each lobster so destroyed, caught, bought, sold, exposed for sale, or possessed: *Provided, however*, If it appears that it was intended to liberate them in accordance with the provisions of this act, the persons having such lobsters in possession shall not be liable to any of the penalties herein provided for, though he may have failed, for any cause not within his control, to so liberate them.

SEC. 41. It shall be unlawful to can, preserve, or pickle lobsters less than 10½ inches in length, alive or dead, measured as aforesaid; and for every lobster canned, preserved, or pickled contrary to the provisions of this section every person, firm, association, or corporation so canning, preserving, or pickling shall be liable to a penalty of $1 for every lobster so canned, preserved, or pickled contrary to the provisions of this section, and a further penalty of $300 for every day on which such unlawful canning, preserving, or pickling is carried on.

SEC. 42. All barrels, boxes, or other packages in transit containing lobsters shall be marked with the word lobsters in capital letters, at least 1 inch in length, together with the full name of the shipper. Said marking shall be placed in a plain and legible manner on the outside of such barrel,

boxes, or other packages; and in case of seizure by any duly authorized officer of any barrels, boxes, or other packages in transit, containing lobsters, which are not so marked, or in case of seizure by such officer of barrels, boxes, or other packages in transit containing lobsters less than the prescribed length, such lobsters as are alive and less than the prescribed length shall be liberated and all such lobsters as are of the prescribed length found in such barrels, boxes, or packages, together with such barrels, boxes, and packages, shall be forfeited and disposed of under the provisions of section 47 of this act.

SEC. 43. Every person, firm, association, or corporation who ships lobsters without having the barrels, boxes, or other packages in which the same are contained marked as prescribed in the previous section shall upon conviction be punished by a fine of $25, and upon subsequent conviction thereof by a fine of $50; and any person or corporation in the business of a common carrier of merchandise who shall carry or transport from place to place lobsters in barrels, boxes, or other packages not so marked shall be liable to a penalty of $50 upon such conviction thereof.

SEC. 44. All cars in which lobsters are kept, and all lobster cars while in the water, shall have the name of the owner or owners thereof on the top of the car, where it may plainly be seen, in letters not less than three-fourths of an inch in length, plainly carved or branded thereon, and all traps, cars, or other devices for the catching of lobsters shall have, while in the water, the owner's name carved or branded in like manner on all the buoys attached to said traps or other devices, under a penalty of $10 for each car and $5 for each trap or device not so marked; and if sufficient proof to establish the ownership of such cars or traps can not be readily obtained, they may be declared forfeited, subject to the provisions of section 47 of this act.

SEC. 45. All persons are hereby prohibited from setting any lobster traps within 300 feet of the mouth or outer end of the leaders of any fish weir, under a penalty of $10 for each offense.

SEC. 46. Whoever takes up, or attempts to take up, or in any way knowingly and willfully interferes with any lobster trap while set for use, without the authority of the owner thereof, shall be punished by a fine of not less than $20, nor more than $50; *Provided, however,* That no action, complaint, or indictment shall be maintained under this section unless the name of the owner of all such traps shall be carved or branded in legible letters, not less than three-fourths of an inch in length, on all the buoys connected with such traps.

SEC. 47. When any lobsters are seized by virtue of the provisions of this act, it shall be the duty of the officer making such seizure to cause such lobsters, so seized, as he is not required by law to liberate, together with the cars, traps, barrels, boxes, or other packages in which they are contained, to be appraised within 24 hours after the time of such seizures by three disinterested men residing in the county where such seizure is made, to be selected by him, and the lobsters, cars, traps, barrels, boxes, or other packages so seized and appraised shall thereupon be sold by the officer making the seizure thereof, at such time and in such manner as shall by him be deemed proper. The officer making such seizure and sale shall within ten days after the time of such seizure file a libel in behalf of the State before a trial justice, or a judge of a police or municipal court of the county in which such seizure was made, setting forth the fact of such seizure, appraisal, and sale, the time and place of the seizure, the number of lobsters, cars, traps, barrels, boxes, or other packages so seized and sold, and the amount of the proceeds of such sale; and such trial justice or judge shall appoint a time and place for the hearing of such libel, and shall issue a notice of the same to all persons interested to appear at the time and place appointed, and show cause why the lobsters, cars, traps, barrels, boxes, or other packages so seized and sold, and the proceeds of such sale, should not be declared forfeited, which notice shall be served upon the owner, if known, and by causing an attested copy of such libel and notice to be posted in two public and conspicuous places in the town in which the seizure was made, seven days at least before the time of hearing.

If any person appears at the time and place of hearing, and claims that the lobsters, cars, traps, barrels, boxes, or other packages so seized and sold were not liable to forfeiture at the time of seizure, and that he was entitled thereto, the trial justice or judge shall hear and determine the cause, and if he shall decide that such lobsters, cars, traps, barrels, boxes, or other packages, at the time of seizure, were not liable to forfeiture, and that the claimant was entitled thereto, he shall order the proceeds of such sale to be paid to the claimant; if no claimant shall appear, or if such trial justice or judge shall decide that such lobsters, traps, cars, barrels, boxes, or other packages, at the time of the seizure, were liable to forfeiture, or that the claimant was not entitled thereto, he shall decree a forfeiture of such lobsters, cars, traps, barrels, boxes, or other packages, and of the proceeds of sale, and shall order the proceeds of sale, after deducting all lawful charges, to be paid to the county

treasurer, and by him to the State treasurer, to be used as directed in section 48 of this act, and shall render judgment against the claimant for costs to be taxed as in civil suits, and issue execution therefor against him in favor of the State, which costs, when collected, shall be paid in to the treasurer of the county, and by him to the treasurer of the State, to be added and made a part of the appropriation for sea and shore fisheries. The claimant shall have the right of appeal to the next supreme judicial court or superior court in the county, upon recognizing and paying the fees for copies and entry as in cases of appeal in criminal cases. The fees and costs of seizure, appraisal, and sale, and in all other proceedings in the case, shall be as provided by law in criminal cases, and in case a forfeiture shall be declared, shall be paid out of the proceeds of the sale, otherwise shall be paid by the county, as in criminal cases.

SEC. 48. All fines and penalties under this act may be recovered by complaint, indictment, or action of debt brought in the county where the offense is committed. The action of debt shall be brought in the name of the commissioner of sea and shore fisheries, and all offenses under or violations of the provisions of this statute may be settled by the commissioner of sea and shore fisheries, upon such terms and conditions as he deems advisable. All fines, penalties, and collections under this act shall be paid into the treasury of the county where the offense is committed, and by such treasurer to the State treasurer, to be added to and made a part of the appropriation for sea and shore fisheries.

SEC. 49. The commissioner of sea and shore fisheries may take fish of any kind, when, where, and in such manner as he chooses, for the purposes of science, of cultivation, and of dissemination, and he may grant written permits to other persons to take fish for the same purposes, and may introduce or permit to be introduced any kind of fish into any waters.

The following special act was passed at the 1899 session of the legislature:

SEC. 1. No person shall take, catch, kill, or destroy any lobsters between the 1st day of July and the 1st day of September in each year, under a penalty of $1 for each lobster so taken, caught, killed, or destroyed, in the waters of Pigeon Hill Bay, so called, in the towns of Millbridge and Steuben, within the following points, namely: Commencing at Woods Pond Point, on the west side of Pigeon Hill Bay; thence easterly to the Nubble, on Little Bois Bubert Island; thence by the shore to the head of Bois Bubert Island; thence northerly to Joe Dyers Point, so called; thence by the shore around Long Cove and the creek; thence to the head of Pigeon Hill Bay aforesaid; thence by the shore to the first-mentioned bound.

SEC. 2. All fines and penalties under this act may be recovered as provided in section 48 of chapter 285 of the Public Laws of 1897.

IMPORTATIONS OF LIVE LOBSTERS.

For some years there have been considerable importations of live lobsters into Maine from the British Provinces, particularly from New Brunswick; previous to the closing up of the canning industry they were more numerous than at present, as considerable numbers were brought in by boat fishermen for the canneries at or near Eastport. The importations are now made by the dealers, who frequently send their own smacks into the Provinces for a supply when lobsters are scarce in the State.

The following table shows the importations into the State, by customs districts, for the fiscal year 1898:

Customs districts.	1898.	
	Pounds.	Value.
Aroostook	150	$12
Bangor	246,991	43,507
Machias	700	91
Passamaquoddy	327,481	35,373
Portland and Falmouth	214,075	13,037
Waldoboro	43,264	3,211
Wiscasset	28,000	1,120

STATISTICAL SUMMARY OF THE LOBSTER INDUSTRY IN MAINE IN 1898.

The following tables show the statistical data relating to the fishery for 1898, except the wholesale trade of Rockland and Portland, which is shown elsewhere.

While Hancock County leads in the number of vessel fishermen with 173, Knox County has the largest number of persons transporting, 78. In the boat fishermen Washington County leads with 639, followed closely by Knox County with 606. In the total number of persons employed Knox County leads with 749, while Washington and Hancock counties have very nearly the same number, 695 and 683, respectively. The total number of persons employed was 3,304.

Hancock County leads in the number of vessels fishing, 78, valued at $33,000, while Knox County leads in the number of transporting vessels, 33, valued at $51,900, and is also second in the number of fishing vessels. Cumberland County is second in the number of transporting vessels. This county has more steam transporting vessels than all the other counties combined, 8, valued at $31,200. In the matter of boats engaged in the shore fishery Knox County also has the preeminence, with 696 boats, valued at $37,175. Lincoln, Hancock, and Washington counties follow in the order named, and are all three very close to each other.

Hancock County leads in the number of pots used in the vessel fishery, 7,146, while Knox County is second. Knox County leads in the number of pots used in shore fisheries with 39,040, valued at $39,030, and is followed by Lincoln County with 29,190 pots, valued at $29,190.

In the matter of shore property Lincoln County leads with $16,917, although if the property used in the wholesale trade had been included in this table Cumberland County would lead. In the total investment Knox County leads with $169,056. Hancock County comes second, with $136,651, followed by Washington and Cumberland counties, respectively. The total investment for the whole State is $616,668.

In vessel catch Hancock County leads with 444,704 pounds, valued at $47,101. Knox County is second with 286,688 pounds, valued at $29,395. In the boat catch Hancock County also leads with 2,198,518 pounds, valued, at $204,390, while Knox County is a close second with 2,165,256 pounds, valued at $186,968. Lincoln County is third and Washington County fourth. The total catch for the State is 11,183,294 pounds, valued at $992,855.

Table showing by counties the number of persons employed in the lobster fishery of Maine in 1898.

County.	Vessel fishermen.	Transporters.	Boat fishermen.	Shoresmen.	Total.
Washington	30	19	639	7	695
Hancock	173	27	480	3	683
Penobscot	2				2
Waldo			19		19
Knox	55	78	606	10	749
Lincoln	12	11	447	4	474
Sagadahoc		2	98		100
Cumberland	10	45	379	6	440
York	4	3	135		142
Total	286	185	2,803	30	3,304

Table showing by counties the vessels, boats, apparatus, and shore property employed in the lobster fishery of Maine in 1898.

Items.	Washington.		Hancock.		Penobscot.		Waldo.		Knox.	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.
Vessels fishing	10	$5, 850	78	$33, 000	1	$350			28	$13, 250
Tonnage	76		593		5				184	
Outfit		1, 169		4, 995		15				3, 923
Vessels transporting—steam	1	8, 350	2	6, 500					3	18, 000
Tonnage	34		26						31	
Outfit		1, 835		1, 950						5, 175
Vessels transporting—sail	5	8, 500	8	9, 900					30	33, 900
Tonnage	94		99						574	
Outfit		790		885						4, 881
Boats transporting (steamers and launches under 5 tons)	1	1, 100	1	4, 950						
Sailboats fishing	259	56, 170	225	34, 290					212	31, 760
Rowboats fishing	209	2, 390	250	3, 285			17	$255	484	5, 415
Pots used in vessel fisheries	1, 710	1, 710	7, 146	7, 146	82	82			4, 140	4, 140
Pots used in shore fisheries	22, 390	22, 373	23, 880	23, 880			575	575	39, 040	39, 030
Shore property		4, 015		5, 870				102		9, 582
Total		114, 252		136, 651		447		932		169, 056

Items.	Lincoln.		Sagadahoc.		Cumberland.		York.		Total.*	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.
Vessels fishing	6	$4, 200			5	$1, 950	2	$1, 600	130	$60, 200
Tonnage	42				30		16		946	
Outfit		619				335		225		11, 281
Vessels transporting—steam					8	31, 200			14	64, 050
Tonnage					109				200	
Outfit						5, 484				14, 444
Vessels transporting—sail	4	6, 200			10	11, 800	2	550	59	70, 850
Tonnage	73				173		14		1, 027	
Outfit		877				1, 814		65		9, 312
Boats transporting (steamers and launches under 5 tons)	1	1, 100	1	$1, 100					4	8, 250
Sailboats fishing	132	12, 975	1	125	154	13, 635	47	2, 085	1, 030	151, 040
Rowboats fishing	351	3, 571	90	1, 185	186	3, 571	81	1, 860	1, 668	21, 532
Pots used in vessel fisheries	510	510			400	400	250	250	14, 238	14, 238
Pots used in shore fisheries	29, 190	29, 190	2, 138	1, 964	17, 932	17, 932	6, 595	6, 595	141, 740	141, 539
Shore property		16, 917		730		9, 416		3, 300		49, 932
Total		76, 159		5, 104		97, 537		16, 530		*616,668

* The property, cash capital, etc., in the wholesale trade of Rockland and Portland is shown elsewhere.

Table showing by counties, vessels, and boats the yield in the lobster fishery of Maine in 1898.

Counties.	Vessel catch.		Boat catch.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Washington	82, 809	$7, 312	1, 545, 895	$132, 877	1, 628, 704	$140, 189
Hancock	444, 704	47, 101	2, 198, 518	204, 390	2, 643, 222	251, 491
Penobscot	1, 264	118			1, 264	118
Waldo			17, 766	1, 713	17, 766	1, 713
Knox	286, 688	29, 395	2, 165, 256	186, 968	2, 451, 944	216, 363
Lincoln	48, 872	4, 157	2, 106, 645	181, 617	2, 155, 517	185, 774
Sagadahoc			384, 900	30, 392	384, 900	30, 392
Cumberland	22, 253	2, 000	1, 401, 338	118, 616	1, 423, 591	120, 616
York	21, 241	1, 841	455, 145	44, 358	476, 386	46, 199
Total	907, 831	91, 924	10, 275, 463	900, 931	11, 183, 294	992, 855

FISH PARASITES COLLECTED AT WOODS HOLE IN 1898.

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The following report is divided into two parts.

In Part I a list of the hosts which were examined, or from which parasites were obtained, is given. In each instance brief mention is made of the parasites found, the dates of examination are given, and where the stomach contents were noted a record is entered. In nearly every case in which no note was made of stomach contents the stomachs were empty.

Adult trematodes and cestodes and a few nematodes have been identified. Many larval cestodes and most of the nematodes have not yet been identified.

The order of arrangement of hosts is substantially that of Dr. H. M. Smith, "The Fishes found in the Vicinity of Woods Hole" (Bulletin of the United States Fish Commission for 1897).

In Part II descriptions are given of new species and of species new to the region.

While this report has mainly to do with the entozoa, I have given descriptions of two ectoparasites: (1) A copepod, found in the cheek of a squeteague (*Cynoscion regalis*). (2) A tristomum (*Epibdella bumpusii* sp. nov.), from the skin of a stingray (*Dasyatis centrura*). In the description of the latter are incorporated some observations on the process of egg-making as it was seen in this interesting species.

PATHOLOGICAL CONDITIONS.

It was under consideration to arrange in a third part such cases as might be referred to as pathological or diseased conditions. This proved undesirable, since it would have caused needless repetition. For convenience of reference, however, are here arranged the principal cases where damage, more or less serious, resulted to the tissues of the host from the presence of parasites.

1. Cyst with trematode ova, p. 297, figs. 82–84.
2. Immature distoma encysted in the skin of the cunner, p. 296, figs. 76–81.
3. On the occurrence of cysts in the stomach-wall of the blue-fish, p. 301, fig. 101.
4. On cysts in the stomach-wall of the black sea bass, p. 301, figs. 103, 104.
5. Cysts from kidneys of scup, p. 301.
6. *Acanthocheilus nidifex*, p. 303, fig. 116.
7. *Cyprinodon variegatus*, p. 277.
8. *Galeocerdo tigrinus* (not due to entozoa), p. 270, fig. 102.
9. *Morone americana*, p. 279.
10. *Catostomus commersonii*, p. 276.

In this connection reference may be made to *Tetrarhynchus bicolor*, which was found burrowing into the stomach coats of the leopard shark (*Galeocerdo tigrinus*), and to *T. elongatus*, whose extraordinarily long blastocysts appear to be always present in the liver of the sunfish (*Mola mola*). *Dibothrium plicatum* appears to produce more or

less irritation by its attachment to the walls of the rectum of the sword-fish (*Xiphias gladius*), and *Echinorhynchus proteus*, in almost all cases where seen in the squeteague (*Cynoscion regalis*), the blue-fish (*Pomatomus saltatrix*), and in former years in the striped bass (*Roccus lineatus*), penetrates the intestinal wall of its host, causing various degeneration alterations in the surrounding tissues.

Summary of results (for details see Part I).

Host.		Parasites.					
Scientific and common names.	No. examined.	Nematodes.	Acanthocephala.	Trematodes.	Cestodes. Encysted.	Cestodes. Free.	Stomach contents.
1. Mustelus canis, Smooth dog-fish	16				Few.	Many (2 species).	Crabs, fish.
2. Galeocerdo tigrinus, Leopard shark	2	Many.				Numerous	Fish, mollusks, etc.
3. Carcharhinus obscurus, Dusky shark	4					Numerous (5 species).	Fish.
4. Sphyrna zygæna, Hammerhead shark	3	2				Few (2 species).	Fish, squid.
5. Carcharias littoralis, Sand shark	14					Numerous	Fish.
6. Squalus acanthias, Spiny dog-fish	100	1			Few.	1	Fish.
7. Raja ocellata, Big skate	3	1				1	Annelids, squid.
8. Raja erinacea, Common skate	8	5				1	Crabs, annelids, shrimp, etc.
9. Tetronarce occidentalis, Torpedo	5				3	9	Fish.
10. Dasyatis centrura, Stingray	7				Few.	Many (11 species).	Crustacea.
11. Myliobatis freminvillei, Sharp-nosed ray.	1					Numerous (3 species).	Mollusk.
12. Anguilla chrysypa, Common eel	3	1			Few.		Fish.
13. Clupea harengus, Herring	1	1			Few.		Shrimp, copepods, etc.
14. Brevoortia tyrannus, Menhaden	7	3			Few.	Many (larvæ).	
15. Cyprinodon variegatus, Short minnow.	2						
16. Tylosurus marinus, Gar-fish	3			1		Numerous (larvæ).	Fish.
17. Sarda sarda, Bonito	37			Numerous	Few.		Fish.
18. Scomberomorus regalis, Spanish mackerel.	1				Numerous		Fish.
19. Xiphias gladius, Sword-fish	2	24				6	Fish, squid.
20. Naucrates ductor, Pilot-fish	1						
21. Pomatomus saltatrix, Blue-fish	8	1			Numerous		Fish, squid.
22. Palinurichthys perciformis, Rudder-fish.	14		1	Numerous		Numerous (larvæ).	Small crustacea, mollusks, and squid.
23. Rhombus triacanthus, Butter-fish	9	Numerous			Few.		
24. Morone americana, White perch	3			Numerous			Shrimp.
25. Centropristes striatus, Black sea-bass	2	Few.			Numerous		Fish.
26. Stenotomus chrysops, Scup	53	Numerous		Few.	Few.	Many (larvæ).	Hydroids, annelids, crustacea, squid.
27. Cynoscion regalis, Squeteague	47	Many.	Few.		Many.	Numerous (larvæ).	Fish.
28. Tautogolabrus adspersus, Cunner	22			Very numerous.	Few.		Fish, seaweeds, etc.
29. Spheroides maculatus, Puffer	3		1	Numerous	1		
30. Mola mola, Sun-fish	1			Numerous (4 species).	Few.	Few.	
31. Myoxocephalus æneus, Sculpin	1	1					
32. Prionotus carolinus, Sea robin	9	Few.		3	Few.		Fish.
33. Lopholatilus chamæleonticeps, Tile-fish.	5	Few.		1		1	Crabs.
34. Opsanus tau, Toad-fish	2	8					Fish.
35. Merluccius bilinearis, Silver hake	6	Few.		Few.	Many.	Numerous (larvæ).	Fish.
36. Pollachius virens, Pollock	1	50		100	Many.		
37. Paralichthys dentatus, Summer flounder.	24	Few.	Few.	Few (2 species).	Numerous	Numerous (larvæ).	Squid, fish.
38. Limanda ferruginea, Sand dab	1					1	
39. Pseudopleuronectes americanus, Winter flounder.	3						
40. Lophius piscatorius, Goose-fish	3	Many.	3	11	Numerous	Numerous (larvæ).	

List of forms described in Part II.

Parasite.	Host.	Plate.	Figure.
Parasitic copepod	Cynoscion regalis	33	1–5
Octobothrium denticulatum Olsson	Pollachius virens	33	6–10
Epibdella bumpusii sp. nov	Dasyatis centrura	34	11–15
Distomum ocreatum Molin	Pollachius virens; Merluccius bilinearis	35	16–24
Distomum appendiculatum Rudolphi (?)	Paralichthys dentatus	36	25–26
Distomum fœcundum sp. nov	Lopholatilus chamæleonticeps	36; 37	27–35; 36–37
Distomum vitellosum sp. nov	Merluccius bilinearis	37	38–39
Distomum pudens sp. nov	Paralichthys dentatus	37	40–47
Distomum vibex sp. nov	Spheroides maculatus	38	48–51
Distomum pyriforme sp. nov	Palinurichthys perciformis	38	52–59
Distomum areolatum Rudolphi (?)	Morone americana	39	60–63
Distomum dentatum sp. nov	Paralichthys dentatus	39	64–67
Distomum fragile sp. nov	Mola mola	39	68–70
Distomum sp	Prionotus carolinus	39	71
Distomum sp	Stenotomus chrysops	39	72
	Paralichthys dentatus	40	73–75
Immature distoma encysted in skin of cunner	Tautogolabrus adspersus	40	76–81
Cysts with trematode ova	Morone americana	40	82–84
Gasterostomum ovatum Linton	Lobotes surinamensis		
Gasterostomum arcuatum sp. nov	Sarda sarda	41	85–90
Gasterostomum sp	Tylosurus marinus	41	91
Calyptrobothrium occidentale sp. nov	Tetronarce occidentalis	41	92–97
Platybothrium sp	Sphyrna zygæna	42	98–99
Larval cestode	Sarda sarda	42	100
Cestode cysts in stomach-wall of blue-fish	Pomatomus saltatrix	42	101
Cysts from kidney of scup	Stenotomus chrysops		
Cysts in stomach-wall of black sea-bass	Centropristes striatus	42	103–104
Ascaris clavata Rudolphi	Pollachius virens	43	105–108
Ascaris habena sp. nov	Opsanus tau	43	109–115
Acanthocheilus nidifex sp. nov	Galeocerdo tigrinus	43	116–119
Ichthyonema sanguineum Rudolphi (?)	Paralichthys dentatus	43	120–121

References to my former papers have been inserted in Part I in all cases where forms were identified as belonging to species therein mentioned or described. As a rule, references are made only to record of latest date, and are not repeated under the same host, but are given under the first date on which the species concerning which reference is made was found.

A list of the papers to which references are made is here given for convenience:

Notes on entozoa of marine fishes of New England. Rept. U. S. F. C. 1886, pp. 453-511; pl. I–VI.

Notes on entozoa of marine fishes of New England, Part II. Rept. U. S. F. C. 1887, pp. 719–899; pl. I–XV.

Notes on entozoa of marine fishes of New England, Part III. Rept. U. S. F. C. 1888, pp. 523-542; pl. LIII–LVIII.

Notes on larval cestode parasites of fishes. Proc. U. S. N. M., vol. XIX (1897), pp. 787–824; pl. LXI LXVIII.

Notes on cestode parasites of fishes. Proc. U. S. N. M., vol. XX (1897), pp. 423–456; pl. XXVI–XXXIV.

Notes on trematode parasites of fishes. Proc. U. S. N. M., vol. XX (1897), pp. 507–548; pl. XL–LIV.

The authority for the names of fishes used in this report is The Fishes of North and Middle America, Bulletin U. S. National Museum, No. 47, Jordan & Evermann.

PART I.

1. Mustelus canis, *Dog-fish.*

(1) July 20; one, small; stomach with fragments of crabs. *Calliobothrium verticillatum* (Cestode Parasites of Fishes, p. 447, pl. XXXIV, figs. 6, 7) and mature proglottides of *Rhynchobothrium bulbifer* (Cestode Parasites of Fishes, p. 448) in spiral valve.

(2) July 23; one; stomach contents not noted, probably empty. Enormous numbers of *R. bulbifer*, young and adult together, in spiral valve. No other entozoa noted.

(3) July 25; one; crabs in stomach. Degenerate waxy cysts in stomach-wall. *C. verticillatum*, 7, spiral valve. *R. bulbifer*, 23, spiral valve.

(4) July 26; one; stomach contained a partly digested fish, probably a squeteague, which may have been taken in the pool, where the dog-fish had been confined for a few days. *C. verticillatum*, 2; *R. bulbifer*, 12, in spiral valve.

(5) July 29; two; stomach contents not noted. From the spiral valve of one were obtained 19 *R. bulbifer* and 6 *C. verticillatum;* from the other about 50 *Rhynchobothrium tumidulum.* There was also an unusually large number of small cysts in the stomach-wall. (See Notes on the Larval Cestodes of Fishes, pl. VI, fig. 6.)

(6) July 30; two; stomach contents not noted. In the spiral valve of one there were found 3 *R. bulbifer* and 1 *R. tumidulum;* from the other, 11 *C. verticillatum* and 4 *R. bulbifer.* The second specimen had been in the pool for some time.

(7) August 1; three; stomachs empty. These fish had been in the pool for several days, and had been dead for some time before they were examined. The alimentary canal showed some signs of decomposition. From the spiral valve of the first were obtained 26 specimens of *R. bulbifer*, the scolices still alive and moderately active. From the second 13 specimens of the same species were got and also 2 of *C. verticillatum.* The latter were in poor condition, the anterior segments having disintegrated; the former were in good condition and still active. In the spiral valve of the third were 24 *R. bulbifer* and 10 *C. verticillatum.* These parasites were not attached to the mucous membrane, but were lying loose in the contents of the intestine. It would appear that with the beginning of decomposition the heads soon detach themselves from the walls of the host.

(8) August 12; one; stomach with crabs. Spiral valve contained 12 specimens of *C. verticillatum* and 12 of *R. tumidulum.*

(9) August 19; one; taken from pool and had been dead for some time. Three or four *C. verticillatum* in spiral valve in poor condition.

(10) August 24; one; the specimen had been kept in confinement for a week or more, and had been dead several hours before it was examined. Nothing in stomach except mucus, and no entozoa in alimentary canal.

(11) August 25; three; same conditions as preceding. A few fragments of *R. bulbifer* found in spiral valve, but in poor condition.

It may be concluded from the foregoing examples that entozoa remain living for but a few hours in the intestinal tract after the death of the host. They quickly become flaccid and soon show the effect of the digestive fluids, and later of decomposition. Presumably they require the presence of oxygen in the intestinal blood-vessels, and as soon as this supply is cut off they quickly succumb. When they are placed in normal salt solution while still active they may be kept alive for hours, and by adding a small amount of nutrient material and pepsin will not only live for days but may increase in size.

2. Galeocerdo tigrinus, *Leopard Shark.*

(1) August 11; one; stomach contents were sand, one pod of a string bean, and two tough masses of flesh, mainly coarse fibrous tissue, not identified. The color of these pieces was about that of fresh "sea pork" (*Amarœcium*), and the structure something like that of the "foot" of the winkle (*Sycotypus*).

Mr. Vinal N. Edwards reported to me the contents of the stomach of another specimen taken on August 12, but not brought into the laboratory, which consisted of a rather curious collection,

namely, one chicken wing with the feathers on it, two slices of beefsteak, a few pieces of cucumber rind, two large pieces of "sea pork," a piece of rope yarn, partly raveled out, with other débris. Evidently a bucket of waste from the cook's galley of some passing vessel had been thrown overboard, and the shark had scooped up the whole mess.

Large numbers of *Thysanocephalum crispum* (Cestode Parasites of Fishes, p. 448), large and small, with enormous numbers of free proglottides in the spiral valve. The scolices were found attached to the mucous membrane. The pseudobothria, in such cases, were expanded into a flat fimbriated disk and closely adherent to the mucous membrane. These cestodes were counted and a number of them measured. There were 56 with mature proglottides and 238 young. The latter ranged in length from 30 to 300 mm. The average of 11 representative forms was 128 mm. Strobiles, which had ripe proglottides, measured 1.25 meters. This represents an actual total length of something like 100 meters; or, allowing for the maturity of the small specimens, a potential length of 367 meters (approximately ¼ mile), without taking into account the free proglottides, of which there were immense numbers.

Acanthocheilus nidifex sp. nov. (see Part II, page 303, for description) in crypts in stomach-wall and free in pylorus.

(2) August 19; one (2.5 meters in length); stomach contained numerous jaws of squids, some of them of good size; various bones, skull of a fish, numerous ear-bones of fish, the operculum of a mollusk (*Lunatia*), seaweed (*Fucus*), sand and gravel, and a nondescript piece of animal tissue about the size of one's hand, probably the remains of the pectoral fin of a goose-fish.

Large numbers of *Thysanocephalum crispum*, as in every specimen of this shark I have examined, in spiral valve. Also a few small forms not yet identified, heads resembling those of the genus *Spongiobothrium*. There is, however, a fleshy anterior median eminence on the head. The worms are small, and before killing exhibited a tendency to become convoluted.

There were also several free proglottides of an altogether different kind from those of *Thysanocephalum*, of which, as usual, there were enormous numbers. The eggs of *Thysanocephalum* are fusiform in shape, an unusual form among cestode eggs.

Tetrarhynchus bicolor (Larval Cestode Parasites of Fishes, pp. 813–815, pl. LXVIII, figs. 1–6), 36 specimens, firmly attached to stomach-wall, where they had formed deep pits, extending into the muscular layers. Head and neck white, back of collar yellowish. These specimens, when removed from their host and placed in sea-water, contract and expand actively and assume a great variety of shapes.

Two imperfect strobiles without scolices were found in the stomach. Upon sectioning they were found to be identical with sections of *Thysanocephalum* and were so identified. I do not know how to account for their presence in the stomach.

Acanthocheilus nidifex as in shark examined on August 11.

Pathological conditions of pylorus of Galeocerdo tigrinus.—The pylorus of each of the specimens of leopard shark examined was occluded by what appears to be a colloid tumor developed in the submucosa, pl. 42, fig. 102. Although occurring in different places in the two cases they were of the same essential structure in each. A brief description of the first is given. The tumor was first encountered at its anterior end while slitting the pylorus with scissors from the anterior end. It presented a smooth globular stopper-like surface, which apparently completely occluded the lumen of the pylorus. No passage could be found on passing a probe around the periphery of the tumor. On cutting into the lumen at the posterior end of the tumor a narrow passage was discovered, which led back beside the tumor and proved to be continuous with the lumen of the pylorus. This narrow passage diverged from the lumen a short distance in front of the tumor. Two raised folds of epithelium, parallel with each other and lying longitudinal to the axis of the pylorus, led into the passage. The anterior end of the tumor lay 24.5 cm. back of stomach. It was about 9 cm. in length and 2.6 cm. in diameter at its anterior end, its posterior end about 9 cm. in front of the entrance of the bile duct. These dimensions include the mucous membrane, which was pushed into the lumen by the developing tumor. The anterior end was the larger, and the diameter grew gradually less to the posterior end, which terminated in a blunt point. The passage, which remained open, was very narrow, and its epithelium had a different appearance from that of the lumen, both before and behind the tumor.

In the shark examined on August 19 a similar tumor was found about midway of the length of the pylorus, also with a narrow passage beside it. The main lumen was also interrupted at other points. I find no mention of such structures in notes made in former years on examinations of this shark, and have no recollection of seeing anything like them before.

3. Carcharhinus obscurus, *Dusky Shark*.

(1) July 18; one; a small skate the only identifiable stomach contents. All the parasites found in this shark were cestodes, as follows:

Anthobothrium laciniatum (Cestode Parasites of Fishes, p. 439), numerous, spiral valve.

Orygmatobothrium angustum (Cestode Parasites of Fishes, p. 443), numerous, spiral valve.

Phoreiobothrium lasium (Cestode Parasites of Fishes, p. 447), numerous, spiral valve.

Tetrarhynchus bisulcatus (Cestode Parasites of Fishes, p. 452), very numerous, pylorus.

The pyloric portion of the stomach, which was about 46 cm. in length, was crowded throughout its length with *Tetrarhynchus bisulcatus*, of which there were approximately 300 specimens. These worms had their heads deeply embedded in the mucous membrane of the pylorus, several of them often being attached at the same point, the strobiles hanging in a festoon from a common pit in the pylorus wall. The mucous membrane, especially in the vicinity of the pits, was in a highly inflamed condition. It is quite conceivable that these parasites might occasion the death of their host by giving rise to such irritation as to occlude the passage by the consequent swelling of the mucous membrane and underlying tissues. In several places the strobiles themselves were so numerous as to offer serious resistance to the passage of food. These specimens were larger than usual, many of them when straightened, while living, measuring as much as 40 cm.

It would appear from a consideration of the occurrence of these parasites in this case that the most defective part of the alimentary canal of the shark is not the spiral valve but the slender pylorus. This is borne out also in the case of the tiger shark. The three species of cestodes found in the spiral valve, while occurring in great numbers and attaching themselves to the mucous membrane, are small and do not occasion much irritation by their presence.

(2) July 19; one, stomach contained a partly digested squeteague. The shark had been confined in the large pool for a week or more. No parasites in stomach or pylorus. In the spiral valve the following cestodes were found:

Anthobothrium laciniatum, few.

Discocephalum pileatum (Entozoa of Marine Fishes of New England, II, pp. 781-787, pl. x, figs. 1-7) 12, large and small.

Orgymatobothrium angustum, few.

The largest specimen of *Discocephalum* was over 40 cm. in length and 7 mm. in breadth. The last segments were almost square and nearly 4 mm. long. The disk-like head, resembling a mushroom anchor, was firmly embedded in the submucous coat in each case, and had to be dissected out before it could be removed.

One of the heads was stained in borax carmine and sectioned. Nerve cells were distinguished in the axis of the head in the basal part of the disk and also in the corrugated portion behind the head. Fibers from the axis continuous with those in the anterior part of the strobile diverge at the base of the disk and make up a large part of that organ. These fibers are most abundant and conspicuous in the basal part of the disk, as are also the vessels of the water-vascular system, which appear, indeed, in the anterior part of the disk, but are there few.

(3) July 27; one, young; remains of young mackerel in stomach. Two species of cestodes were found in the spiral valve.

Anthobothrium laciniatum, 19, both long and short necked varieties.

Phoreiobothrium lasium, 6, largest 32 mm.

(4) August 9; one; stomach contained partly digested fish of good size, probably a squeteague. Unfortunately only the stomach, including the pylorus of this specimen, was examined, the spiral valve having been taken by another for use as a specimen.

At the lower end of the stomach proper, not yet in the constricted pylorus, were four specimens representing three species, which, in view of the stomach contents, are of special interest.

Echeneibothrium (?) larva, 1, active.

Tetrarhynchus bisulcatus, 2, scolices only, active.

Nematode, immature, 1, partly digested.

The two cestodes are just such as are found in the squeteague, the former in the cystic duct and intestine; the other (*Tetrarhynchus*) encysted in the submucosa of the stomach. In the larva there was a faint indication of two red pigment spots back of the bothria. The nematode appeared to be identical with immature forms collected from a squeteague on August 5. The condition of these

specimens is interesting when it is remembered that when forms like these are taken from a squeteague and placed in ordinary sea water or normal salt solution the nematodes will continue active, often for days, while the cestodes usually cease activity after less than a day. When the cestodes were placed in Lang's aceto-picro-corrosive fluid bubbles of gas were given off, indicating the presence of calcareous bodies.

4. Sphyrna zygæna, *Hammer-head Shark.*

(1) July 21; one; stomach contained remains of two menhaden. No entozoa in stomach or pylorus. From the spiral valve were obtained two nematodes, three scolices of *Otobothrium* (Entozoa of Marine Fishes, II, pp. 849–853, pl. XIII, figs. 9–15; XIV, figs. 1–4), and five specimens of *Phoreiobothrium lasium* (Cestode Parasites of Fishes, p. 447). The entozoa in this shark were in poor condition, as if partly macerated.

(2) August 5; one; small; stomach with fragment of partly digested fish. No parasites of any kind found.

(3) August 18; one; stomach contained fragments of squids; spiral valve yielded a few specimens of *Phoreiobothrium lasium.* These specimens were exceedingly spiny, but the spines were easily detached; bothria had fluted posterior borders, and contracted to about one half their length when placed in picro-sulphuric acid; length, 12 to 22 mm.

Also from spiral valve one specimen of the genus *Platybothrium* (Entozoa of Marine Fishes, pp. 820–823, pl. VIII, figs. 8–10; IX, fig. 1). See page 300 for description.

5. Carcharias littoralis, *Sand Shark.*

(1) July 21; one; stomach empty. Large numbers of the cestode *Crossobothrium laciniatum* in spiral valve (Cestode Parasites of Fishes, pp. 445–446), large and small together; also several of the short variety noted in former papers, i. e., forms with mature segments beginning near the head. Whether these are to be looked on as a distinct variety or as individuals in which the proglottis-forming energy is nearly spent I am not certain (Entozoa of Marine Fishes of New England, part II, pl. VII, fig. 4, p. 800).

(2) July 23; one; stomach contents not noted, probably empty.

Numerous *C. laciniatum* in spiral valve.

(3) July 25; one; stomach with partly digested fish, probably flat-fish.

Numerous *C. laciniatum* in spiral valve.

Numerous Echinorhynchi, partly digested, in stomach; one in pylorus, evidently introduced with the food. *Echinorhynchus acus* often occurs in great numbers in the flat-fish (*Pseudopleuronectes americanus*).

(4) July 27; three; stomachs contained fish (menhaden). The only parasites found were *C. laciniatum*, numerous in each. In one they were mainly adult, the longest measuring 42 cm. In one of the others a large number were young. These, contrary to their usual habit, were rather firmly fixed by their sucking-disks to the intestine. One of the short variety found in this lot.

(5) July 28; one; stomach with a fish (tautog). Forty-four specimens of a parasitic copepod (*Pandarus*) on fins. As usual, large numbers of *C. laciniatum* in spiral valve. A large proportion of these were young, and there were no free mature proglottides, which are always very abundant in lots containing mature strobiles. The longest measured about 160 mm. in length.

(6) July 29; one; stomach empty. *C. laciniatum* in considerable numbers in spiral valve.

(7) July 30; two; stomachs with partly digested fish. Fewer than ordinary parasites in spiral valve. One contained 10 *C. laciniatum* from 80 to 110 mm. in length; the other contained the same number, all rather small, 5 to 25 mm. in length.

(8) August 1; one; stomach with good-sized squeteague which had been bitten into two pieces. Spiral valve with numerous C. *laciniatum*, young and adult.

(9) August 8; one; stomach empty. *C. laciniatum* in spiral valve, numerous, young and adult.

(10) August 13; one; stomach empty. The shark had been confined in the pool for several days. *C. laciniatum*, young and adult, 42 in all, in spiral valve.

(11) August 18; one; stomach contained the claw of a small crab. *C. laciniatum*, young and mature, 87 in all, in spiral valve.

Very careful search was made in the spiral valve of a number of the foregoing specimens of sand sharks for other forms than the ever-recurring *C. laciniatum*, but without success.

6. Squalus acanthias, *Spiny Dog-fish.*

August 20; viscera of over 100 examined. These were collected at Rockport, Mass., by Prof. H. V. Neal, of Knox College, Galesburg, Ill. They had been placed in formalin, where they had lain about one week before they were brought to Woods Hole. The condition of the material was fairly good, so that if there had been entozoa in the alimentary canal at the time it was put into the formalin they should have been in good enough state of preservation for identification at least. The tissues of the stomach and spiral valve, the only parts saved, were in fair condition. No evidence of decomposition could be detected, and yet, after a careful search, no entozoa were found, except a small, immature nematode in the stomach of one, and the head and about 3 mm. of the body of a cestode, probably *Anthobothrium* from a spiral valve, with two or three cysts their tissues degenerated, in the stomach wall. Most of the spiral valves had been opened before preserving.

A few fish bones and scales and a small amphipod (*Gammarus*) were found in the stomach and intestine.

7. Raja ocellata, *Big Skate.*

(1) August 10; one; stomach empty. This specimen had been put in the pool in April. It had been dead probably a day before it was examined. It was in poor condition, evidently the result of confinement. Only mucus found in stomach and intestine. One cyst in stomach wall filled with a cheesy, degenerate tissue. One nematode found in dish during the examination, probably from the intestine; an immature female, 21 mm. in length, living, though not very active; very transparent; length of œsophagus 2 mm.; cuticle thrown into fine transverse wrinkles; posterior end bluntly rounded with mucronate tip; length of tail 0.11 mm. Under the layer of longitudinal muscles the cells forming the intestinal tract could be seen. Upon focusing carefully, an open, somewhat reticulated, structure appeared in this cellular layer.

(2) August 11; another specimen taken at Menemsha Bight, Vineyard Sound, had no parasites.

(3) August 16; one; stomach with a large squid (*Loligo*) and one or two annelids; intestine with many annelids only partly digested.

One entozoan (*Rhynchobothrium imparispine*) [Cestode Parasites of Fishes, p. 450] in intestine. The following measurements of the living specimen, in millimeters, are appended: Length 60; length of head and neck about 8, but very variable; average length of last six segments 1.5; length of last segment 3; breadth of last segment 1. Bothria on flat sides of strobile, varying from long elliptical and parallel to axis of body to cup-shape with cavities directed forward, then standing at about right angles to the axis of the body, or even with free borders directed forward in advance of apex of head; free border of bothria emarginate; color of worm yellowish white; first segments begin very close behind the contractile bulbs, at first broader than long, soon becoming squarish and ultimately longer than broad; reproductive cloaca in a deep lateral notch irregularly alternate and situated rather nearer the posterior end of the segment.

8. Raja erinacea, *Common Skate.*

(1) July 20; one; copepods and hermit crab in stomach. One nematode found in stomach.

(2) July 21; two; stomachs empty. One nematode in stomach of each. One *Echeneibothrium variabile* in spiral valve (Cestode Parasites of Fishes, p. 440).

(3) July 23; one; stomach empty. Two nematodes in stomach.

(4) July 26; one; stomach contained crabs (*Panopeus*) and annelids (*Nereis*). No entozoa except a few cysts, not determinable, in stomach wall.

(5) August 12; one; stomach and intestines with partly digested crabs (*Panopeus*); female, with one egg containing an embryo.

(6) August 16; two; stomachs with small shrimp (*Crangon vulgaris*). No entozoa.

9. Tetronarce occidentalis, *Torpedo.*

(1) July 25; three; stomach and intestine contained nothing but mucus (exceptionally tenacious and of a brown color), one small fragment of a shell, and a part of a small fish vertebra. The digestion of the torpedo appears to be very powerful. The walls of both stomach and intestine are remarkably thick and heavy. The viscera, after removal from the body, were left lying in a pail for about 2½ hours. When they were then examined several holes had been digested through the intes-

tinal wall. One of the specimens had no entozoa; the other had in the spiral valve 1 large and 6 small specimens belonging to Monticelli's genus *Calyptrobothrium*, which I refer to a new species, *C. occidentalis*. See p. 298 for description.

(2) July 26; one; contents of stomach and intestine as in lot (1), viz, brown, viscid mucus. In the intestine the only identifiable food substance was the crystalline lens of a fish. Two specimens of *C. occidentalis* in spiral valve. Three cysts in intestinal wall, each containing blastocyst and a larval *Rhynchobothrium* agreeing with form described in Notes on Cestode Parasites of Fishes, page 800, pl. LXIV, figs. 9–11 (*R. imparispine*). The liberated larva remains attached to the blastocyst, which possesses an exhalent pore at the posterior end, and evidently functions as a nutrient vessel for the young worm. This torpedo was taken at the same time as those examined on July 25, but had been kept alive in a tank until the next day.

(3) August 22; one, large female with one young; the stomach contained a partly digested flounder (*Paralichthys dentatus*) about 45 centimeters in length. No entozoa except what seemed to be loose segments, immature, of a small cestode in the spiral valve.

10. Dasyatis centrura, *Stingray*.

(1) July 29; two; stomachs empty. The first specimen yielded the following cestodes:
Anthobothrium pulvinatum, 40 (Cestode Parasites of Fishes, pp. 439–440, pl. XXXIII, fig. 1).
Rhinebothrium flexile, 1 (Entozoa of Marine Fishes, II, pp. 768–771, pl. V, figs. 3–5).
Rhinebothrium cancellatum, 3 (Entozoa of Marine Fishes, II, pp. 771–775, pl. V, figs. 6–8).
Anthocephalum gracile, 10 (Entozoa of Marine Fishes, II, pp. 794–796, pl. VII, figs. 1, 2).
Phyllobothrium foliatum, 16 (Cestode Parasites of Fishes, p. 443, pl. XXXIII, fig. 6).
Parataenia medusia, 12 (Cestode Parasites of Fishes, p. 440).
Rhynchobothrium hispidum, numerous (Ento. Mar. Fishes, II, pp. 833–835, pl. XI, figs. 12–17).
Synbothrium filicolle, from cyst, 1 (Larv. Cest. Par. Fishes, pp. 815–820, pl. VIII, figs. 7–12).

A few cysts in spleen and stomach-wall for most part consisting of degenerate tissue. The second specimen, a very large one, had been dead some five or six hours before the parasites were removed. They were not in first-class condition. The following entozoa were obtained:
Rhinebothrium flexile, 1.
Spongiobothrium variabile, 7 (Cestode Parasites of Fishes, p. 442).
Lecanicephalum peltatum, 9 (Entozoa of Marine Fishes, II, pp. 802–805, pl. IX, figs. 2–4).
Acanthobothrium paulum, 30 (Entozoa of Marine Fishes II, pp. 816–819, pl. VIII, figs. 1–7).

With exception of the cysts the above-named cestodes were found in the spiral valves of the rays.

(2) August 1; one; stomach with remains of a crustacean (*Callianassa*). The following cestodes were obtained from the spiral valve: *Anthobothrium pulvinatum*, 2, and numerous free proglottides; *Spongiobothrium variabile*, 1; *Anthocephalum gracile*, 3, longest measuring 46 mm. *Phyllobothrium foliatum*, 9; *Rhynchobothrium hispidum*, numerous.

Free proglottides from several of these cestodes were observed to keep up active progressive movements in sea-water for four hours after they were collected, that is until they were killed. The resemblance, in such cases, to a trematode is very striking.

(3) August 17; one, small; stomach empty. No parasites, except a few cestode cysts in spleen and stomach-wall. Some of these contained blastocysts, but the larvæ were too young to be identified, probably *Rhynchobothrium*.

(3) August 18; one. This ray was placed in the pool and was not killed during my stay at Woods Hole. Six external trematode parasites collected, *Epibdella bumpusii* sp. nov. See page 286.

(4) August 22; one, small; stomach empty. One *Anthobothrium pulvinatum* in spiral valve. One cyst in spleen from which a blastocyst was obtained, not far enough developed for identification. Other cysts in wall of stomach and pylorus had degenerated to yellow masses of cheesy consistency.

(5) August 25; one; stomach empty. In spiral valve were found: *Anthobothrium pulvinatum*, 2; *Phyllobothrium foliatum*, 1; *Parataenia medusia*; *Rhynchobothrium* sp.

11. Myliobatis freminvillei, *Sharp-nosed Ray*.

July 27; one; stomach contained pieces of fleshy part of some large univalve mollusk, probably *Sycotypus*. From the spiral valve were obtained:
Rhynchobothrium longicolle (Cestode Parasites of Fishes, p. 441, pl. XXXIII, figs. 2–4) very numerous.
Rhynchobothrium agile (Cestode Parasites of Fishes, p. 451, pl. XXXIV, figs. 12–15) 30.

From the pylorus was obtained a single specimen of *Tetrarhynchus robustus* (Cestode Parasites of Fishes) p. 452.

One of the larger specimens of *R. agile* measured 95 mm. in length. It was noticed that these specimens contracted very greatly when placed in the killing fluid (Long's aceto-picro-mercuric fluid), especially the mature and maturing proglottides, some of the latter contracting to one-fourth their length. Specimens were then stretched on the bottom of a glass dish and allowed to lie there a short time until they were fastened by their own mucilage. They did not then contract when the killing fluid was placed on them.

11a. Catostomus commersonii, *Common Sucker.*

August 26, I received a specimen of sucker and a bottle containing a large number of parasitic copepods, which were sent to me by Dr. H. M. Smith. Along with the specimens was a letter from J. W. Titcomb, superintendent of the Fish Commission station at St. Johnsbury, Vt. The fish and parasites had been collected by I. W. Parks, Montpelier, Vt. Mr. Titcomb wrote:

> Through the courtesy of I. W. Parks, veterinary surgeon at Montpelier, Vt., I have obtained a lot of specimens of the parasite which infested the river there this summer and a sucker which had been attacked by them. It will be noticed that one of the pectoral fins is quite badly eaten and a spot on the fish below it. These parasites usually attack the pectoral fins first. They are sometimes found on the eyes of the fish and apparently stand on their heads in working into the fish.

These parasites belong to the genus *Argulus*, probably *A. catostomi* Dana and Herrick. The abraded place on the side of the fish was examined and the tissues were found to be penetrated by the hyphæ of some fungus, presumably a species of Saprolegnia. Since the mouth parts of Argulus are fitted for piercing and sucking, and not for biting, it seems rather hard to account for the frayed and tattered condition of one of the pectoral fins of this fish. Because of the presence of the fungus noted above, I stated in my letter to Dr. Smith relative to this case that these parasites may not have been wholly to blame for the damage, although the trouble might have been started by them.

Later I received a letter from Mr. Parks, dated September 20, in which he gives an interesting account of his observations on the effect of these parasites on trout and suckers. The following extracts, give the substance of his observations. After speaking of a fish which had no marks of any kind upon it when he first saw it, which was swimming in shallow and clear water, he proceeds:

> First the fish swam along in the usual manner feeding, but soon became uneasy, this increasing until it seemed to become frenzied. This stage does not last more than 30 minutes, however—and then it commenced to turn upon its back and became comatose and soon died. * * * To make sure the parasite was the cause of death I obtained trout and suckers from an adjacent stream, and after placing the sucker in a tank of fresh water I dropped in about fifty of the parasites, which at once attacked the fish. While they were upon the sucker I placed three trout in also. In 55 minutes I noticed signs of frenzy and in 75 minutes coma, and in 90 minutes the first trout was dead, and upon examination I found the left pectoral fin completely stripped, the right eye destroyed, a spot near the tail stripped of the scales the size of a ten-cent piece. I find that suckers can live longer than trout, also the parasites will go from a sucker to trout.

The *Argulidæ*, according to Claus (Zeitschrift fur Wissenschaft, Zool., XXV, 3, 1875, p. 277), live on very different sorts of fish, and chiefly on the plasma of the blood to which they obtain access by means of modified mandibles and maxillæ which are transformed into a piercing and sucking organ.

12. Anguilla chrysypa, *Common Eel.*

(1) July 25; one; stomach empty.

Cestodes: Cysts containing larvæ, on mesentery, several, *Rhynchobothrium imparispine* Lt. (Cestode Parasites of Fishes, p. 450.)

Nematodes; one encapsuled on liver, immature; not yet identified. There was an inflamed patch on the stomach wall and on the intestine, evidently caused by a wound on the side.

(2) August 5; one; partly digested fish in stomach.

One hyaline cyst on viscera, containing a Rhynchobothrium larva. When released it remained attached to the blastocyst.

(3) August 29; one; stomach empty.

The only entozoon found was a single immature cestode larva of the type which I have found in the alimentary canals of a variety of fish; small, with two red spots on the neck. (Larval Cestode Parasites of Fishes, pp. 789–792, pl. LXI, figs. 4–15.) The stomach and intestine were washed and the contents looked over very carefully with the above meager result. The specimen had been in an aquarium for a few days.

13. Clupea harengus, *Herring*.

September 5; one, young; stomach with enormous numbers of copepods of several species, young shrimps in large numbers, and numerous crabs in the megalops stage. The fish was taken with a dip net at the surface where it was feeding. A few small cysts containing blastocysts were found on the viscera. The blastocysts contained larval Rhynchobothria, the hooks of which agree with those figured in my report on larval cestodes (pl. LXIII, fig. 5). The longer hooks measured about 0.017 mm. One of the cysts, average, measured 2 mm. in length and 1.4 mm. in the shorter diameter. One encapsuled nematode was found, immature.

14. Brevoortia tyrannus, *Menhaden*.

(1) July 21; five; stomachs empty.

Elongated cysts and blastocysts on viscera (*Synbothrium*) (?) (Larval Cestode Parasites of Fishes, pp. 815–820, pl. LXVIII, figs. 7–12.)

(2) August 15; two; stomachs empty save sand and fine material not identifiable with lens.

Cestodes: Three elongated cysts on viscera and a considerable number of larval cestodes of same general type as those found in cystic duct of squeteague, although the head seemed to be proportionally larger; red pigment back of head observed in some. (Larval Cestode Parasites of Fishes, pp. 789–792, pl. LXI, figs. 4–15.)

Nematodes: Three small specimens, very slender, and about 8 mm. in length.

15. Cyprinodon variegatus, *Short Minnow*.

July 23; two, each with several tumors caused by psorosperms (*Myxobolus lintoni* Gurley).

August 23; another specimen, which had been kept for a month in an aquarium, also with tumors. On the surface of the tumors a number of small white specks were noticed; this was after the specimen had been lying overnight in 2 per cent formalin; these specks were on the surface and looked like masses of coagulated mucus. When transferred to a slide and examined under considerable magnification they were found to be definitely limited clusters of psorosperms. When flattened under the cover glass they became elliptical in outline.

Dimensions in millimeters: Length of elliptical mass, 0.25; breadth, 0.2; length of single psorosperm, 0.0141; breadth, 0.010; length of oval bodies, 0.004.

No special search was made for this parasite. Dr. Gorham reported that other specimens similarly affected were seen earlier in the summer. Several specimens were taken during the summer with these tumors, but no formal record was kept of them.

16. Tylosurus marinus, *Gar-fish*.

August 27; three, small; stomachs of two empty, other with small fish (silverside). Larval cestodes with two red pigment spots in neck in intestine. (Larv. Cest. Parasites of Fishes, pp. 789–792).

Gasterostomum sp. one, in intestine; see page 298 (fig. 91) for description.

17. Sarda sarda, *Bonito*.

(1) July 20; three; stomachs empty.

Tetrarhynchus bicolor (Larval Cestode Parasites of Fishes, pp. 813–815, pl. LXVIII, figs. 1–6), from cysts under peritoneum.

Gasterostomum arcuatum sp. nov. See page 297 for description; very numerous in pyloric cæca and intestine.

One small nematode, immature, encapsuled on serous coat of intestine.

(2) July 23; one; a small shell in stomach. External copepod parasites in mouth.

One larva in blastocyst, enveloped in a delicate cyst; colorless or white with yellow blotches at the ends. This was found in the muscular tissue near the anus. After removal from the cyst it was active and crawled with progressive motion on the bottom of a watch glass. It appears to be *T. bicolor*.

(3) July 28; two; stomachs empty. No parasites found except copepods, two on one and one on the other, in mouth.

(4) August 1; one; stomach with nearly digested remains of small fish; no parasites.

(5) August 5; eight; stomachs empty except in one case, where nearly digested small fish were found, also jaws of small squid and small arthropods, apparently copepods and amphipods. One slender blastocyst liberated from cyst on pyloric cæca, very active. See page 300 for additional details.

(6) August 8; fourteen; the stomachs of most of them with fragments of nearly digested fish. A few copepod parasites from the mouth of one, other heads not examined. One cyst from viscera, not determined.

Gasterostomum arcuatum, few, from pyloric cæca at juncture with intestine. See (1) ante.

(7) August 10; seven; August 11, one; stomachs of several contained partly digested small fish. One larva (*Tetrarhynchus*), also a few cysts, not determined, from stomach wall. Two of these had become degenerated. Two elongated cysts on pyloric cæca.

(8) August 15; two; stomach contents not noted, probably empty. No parasites found.

18. Scomberomorus regalis, *Spanish Mackerel.*

August 16; one; stomach nearly empty, the vertebra of a small fish being all that was distinguished. Numerous cysts containing blastocysts and larvæ (*Synbothrium*) under serous membrane on pyloric cæca and ovaries. (Larval Cestode Parasites of Fishes, p. 815–820, pl. LXVIII, fig. 7–12.) The posterior end of one of the blastocysts was bifurcate.

19. Xiphias gladius, *Sword-fish.*

July 17; two; stomachs with hake, young cod, and beak of a squid. These fish had a number of trematode parasites on the gills (*Tristomum*), most of which, however, had been removed before I saw the fish. The following were obtained by me:

Ascaris incurva, from stomach, 24, large and small together.

Rhynchobothrium attenuatum (Larval Cestode Parasites of Fishes, pp. 805–806, pl. LXV, figs. 8–11). Three found on serous membrane in vicinity of reproductive organs of one of the fish. One of these larva, while lying in fresh water, extended itself until it was 130 mm. or more in length.

Dibothrium plicatum (Cestode Parasites of Fishes, pp. 430–431). Two specimens from one host and one from the other. These specimens were all in the rectum of their several hosts and firmly attached. In two cases the heads penetrated simply the mucous and submucous coats. The other specimen had penetrated the intestinal wall and was surrounded by a globular cyst about 12 mm. in diameter which protruded into the body cavity.

Tristomum coccineum, from gills; 4 specimens. (Trem. Par. Fishes, pp. 509–510, pl. XL, fig. 9.)

20. Naucrates ductor, *Pilot-fish.*

August 23; one; stomach empty. No entozoa.

21. Pomatomus saltatrix, *Blue-fish.*

(1) July 20; one; stomach with young herring. Numerous small cestode cysts (*Tetrarhynchus*) in stomach wall. Elongated cysts (*Synbothrium*) on mesentery and serous covering of viscera.

(2) July 21; two; stomach of one empty, the other with fragment of squid (*Loligo*). Numerous cysts in stomach wall (*Tetrarhynchus*); several elongated blastocysts with thin or imperfect cysts on viscera (*Synbothrium*).

(3) July 23; one; stomach contained a small cunner (*Tautogolabrus*). The usual large numbers of cysts (*Tetrarhynchus*) in submucosa of stomach. See page 301 for additional notes.

(4) July 25; one; stomach contained pieces of squid (*Loligo*). Numerous cestode cysts on viscera and in liver.

(5) July 30; one; stomach empty. Large cysts containing blastocysts, which were active when liberated, three on mesentery and one in stomach-wall between mucosa and submucosa. The larvæ proved to be examples of the species *Rhynchobothrium speciosum*. (Larval Cestode Parasites of Fishes, pp. 801–805, pl. LXIV, figs. 13–14; LXV, figs. 1–7.)

(6) August 8; two; stomachs contained partly digested fish. No entozoa found except a small, immature nematode in the stomach.

22. Palinurichthys perciformis, *Rudder-fish.*

(1) August 10; one, small; stomach contents not noted. An enormous number of small distoma on and in the pyloric cæca, *Distomum pyriforme.* See page 292 for description.

(2) August 19; six; stomach contents not noted. Larval cestodes in general similar to forms found in squeteague, flounder, goose-fish, etc., in intestine, but very small. Dimensions of living specimens, in millimeters: Length 0.34, breadth 0.17; specimen with head invaginated, length 0.26, breadth 0.14. A few small distoma, *D. pyriforme*, in intestine.

Echinorhynchus pristis, var. *tenuicornis* (Entozoa of Marine Fishes, III, pp. 531–532, pls. IV, figs. 39–41; V, figs. 42–53); from intestine, one.

One small immature nematode also found, from intestine.

(3) August 22; three; stomachs contained small univalve shells (*Trittia trivitata*), and the slender crustacean, quite common among hydroids (*Caprella geometrica*). Larval cestodes, and numerous small distoma, as in lot examined August 10. These entozoa were from the alimentary canal in the vicinity of the pyloric cæca.

(4) August 25; four; stomachs contained young squid (*Loligo pealii*), crustacea. Larval cestodes and small distoma, as in preceding lots, obtained by opening the alimentary canal, and washing contents in a dish of sea water. One of the former appeared to have a more prominent myzorhynchus than usual.

23. Rhombus triacanthus, *Butter-fish.*

(1) July 21; one; stomach contents not noted, probably empty. Numerous immature nematodes on viscera.

(2) July 23; one; stomach contents not noted. One small cyst containing blastocyst and larva (*Rhynchobothrium*), and enormous numbers of immature nematodes on and among the pyloric cæca. The combined bulk of the worms appeared to be almost equal to that of the pyloric cæca.

(3) August 10; three; stomach contents not noted. Serous coat of pyloric cæca with large numbers of immature nematodes.

(4) August 22; four; stomach contents not noted. A few small cysts and numerous small, immature nematodes found on pyloric cæca.

24. Morone americana, *White Perch.*

August 27; three, small; stomach full of shrimps.

Distomum areolatum Rudolphi. See page 293 for description; rather numerous, found in dish in which viscera had been lying.

Numerous pigment patches on viscera generally, especially on liver, but also abundant on mesentery, stomach, and intestine. A study of the tissue affected with these patches confirmed certain conclusions recorded in my Notes on Trematode Parasites of Fishes, page 537.

Large numbers of cysts in various stages of degeneration were found. In most of them ova, which are without doubt the ova of some distomum, formed the nucleus of the cyst. These ova measured about 0.020 and 0.013 mm. in the two principal diameters. They therefore do not belong to *D. areolatum.* The principal steps in the degeneration of the cysts to pigment were represented by, (*a*) one or more ova with cyst of connective tissue just beginning to form, (*b*) others with cyst of connective tissue fully formed, (*c*) others with cyst and the contained ovum or ova surrounded with a waxy secretion, (*d*) a waxy mass with no ova visible, also masses of dark-brown, almost black pigment. Sections of the liver were made, but no pathological conditions were noted further than the presence of pigment patches in the serous coat, some of which contained large numbers of ova; 6,400 estimated in one patch through which sections were made, and about half of them mounted serially.

25. Centropristes striatus, *Black Sea-bass.*

(1) July 28; one; stomach empty. The fish had been in an aquarium for several weeks. The only parasites found were numerous small cysts containing larval cestodes in the submucosa of the stomach. See page 301 for supplementary note.

(2) August 5; one; stomach with a few small fish nearly digested. The fish was taken from an aquarium where it had been kept for several weeks. A few cysts on the mesentery and under the serous coat of the liver. One of the cysts when opened released a blastocyst to which the larval

Rhynchobothrium remained attached when it was forced out by pressure. A few encapsuled nematodes among the cysts on the mesentery, the intestines of which were somewhat folded or crumpled, white by reflected and pale reddish or yellowish brown by transmitted light.

26. Stenotomus chrysops, *Scup.*

(1) July 19; sixteen, about two years old; stomachs empty. Several nematodes and a few cysts on serous covering of viscera. Small cestode larvæ, similar to those found in squeteague, flounder, etc., in intestine.

(2) June 14; small nematodes and cysts from body cavity, collected by Dr. F. P. Gorham, agree with lot (1).

(3) July 25; two; stomachs contained annelids and amphipods. Cestode cyst and nematodes on viscera—same as lot (1).

Leech, slender, yellowish-brown, with three longitudinal rows of white blotches, one on each side and one dorsal, about eighteen in each row; suckers bluish-white. Although this leech was found on the scup, it probably came from one of two flounders which were in the same pail with the scup. In the same pail were, in addition to these, an eel, a blue-fish, and two sea-robins.

(4) July 26; one; stomach with young squid. A few nematodes on viscera, same as in lot (1).

(5) August 4; one; small globular cysts in kidneys, collected by Mr. E. E. Tyzzer. See page 301 for description.

(6) August 5; two; stomachs empty. Small immature nematode on mesentery. Dimensions, in millimeters: Length (alcoholic), 9. Other dimensions from life. The worm was transparent, and the brownish intestine had an anteriorly projecting diverticulum 0.14 in length; length of œsophagus, 1.42; head with prominent papilla on ventral lip and two others less distinct; posterior end slender acuminate; distance from anal aperture to posterior end, 0.14.

(7) August 15; two; stomachs contained hydroids (*Pennaria*). Two small nematodes and one small distomum from viscera. The body of the distomum was covered with minute scale-like spines. For further details see page 296 (fig. 72).

(8) August 22; thirty-one; stomach contents not noted. Careful search was made in the hope of getting more examples of the distomum found in (7). Only a few small, immature nematodes and encysted larval Rhynchobothria found. The latter agree with the form described in my Notes on Larval Cestodes of Fishes, pp. 796–797, plate LXIII, figs. 9–13.

27. Cynoscion regalis, *Squeteague.*

(1) July 18; two; stomachs empty.

Cestodes: Larval Rhynchobothria in cysts on viscera. Larval cestodes in gall bladder, very numerous in one, attached in clusters to mucous lining of gall bladder; in the other few. (Larval Cestode Parasites of Fishes, pp. 789–792, pl. LXI, figs. 4–15.)

Nematodes: Numerous in cysts on viscera. These were small, immature, for the most part of a brown color, especially those recently liberated from cysts.

(2) July 19; five; stomachs contained young herring and butter-fish.

Cestodes: Numerous cysts containing larval Rhynchobothria and Tetrarhynchi on serous covering of viscera. The usual larval cestodes in gall bladder and cystic duct, the clusters forming swellings in the cystic ducts of some, which look as if they might occlude the duct in some cases.

Nematodes: Numerous immature nematodes encysted on serous membrane of viscera.

Acanthocephala: *Echinorhynchus proteus.* Two of the fish with several specimens in intestine. In each case the head and globular bulla had penetrated the intestinal wall and were protruding into the body cavity. (Entozoa of Marine Fishes, part III, pp. 537–538, pl. VIII, figs. 85–88.)

(3) July 23; three; stomachs not noted. Cestode cysts on viscera, especially on mesentery. Large numbers of immature nematodes, free and encapsuled on mesentery.

(4) July 28; three; stomachs with half-digested fish. Numerous cysts (*Tetrarhynchus*) in stomach wall; cystic ducts of two with the usual cestode larvæ.

(5) July 29; eighteen; stomachs with partly digested fish. The usual entozoa in each, viz: Tetrarhynchus larvæ encysted in the stomach wall. Cestode larvæ in cystic duct. Nematode and cestode cysts in mesentery.

(6) August 5; two; stomachs empty. Cystic ducts with the usual larval cestodes, free in the lumen of the duct and in gall bladder, and loosely attached by their heads to the mucous membrane. Masses of cestode cysts and encapsuled nematodes on mesentery.

(7) August 15; eight; stomach contents not noted. Cystic ducts with usual larvæ. Tetrarhynchus larvæ in stomach walls, not abundant. Numerous small, immature nematodes on mesentery. About 20 specimens of *Echinorhynchus proteus* in a cluster in one of the squeteagues, within about 25 mm. of the anal end of the rectum. The heads of these worms had penetrated the intestine and the serous side of the intestine at this place was covered with cysts; some of the latter were opened and revealed waxy concretions similar to those described in a former paper, though in these cases all were small. (Entozoa of Marine Fishes, 1886, p. 497, pl. VI, fig. 5, *a* and *b*.)

(8) August 16; one; stomach contents not noted, probably empty. Larvæ in cystic duct and gall bladder, as usual.

(9) August 25; ten; stomachs with fish and squids. The usual larval cestodes in cystic duct and gall bladder; also in the intestine others similar but smaller, and all with two red blotches in the neck. Larval Tetrarhynchi encysted in stomach wall, small cysts and nematodes on mesentery. One much elongated blastocyst on mesentery of one of the fish. Length of anterior portion in life varying from 7 to 14 mm.; length of the posterior slender portion, 75 mm. or more. When placed in the killing fluid the anterior part, which in life was oblong and translucent, contracted to a globular shape, 5 mm. in length, and became tense, opaque, and of a dead white color; the posterior portion, when straightened in the killing fluid, measured 90 mm. in length, and was transparent and colorless. The larva, when liberated from the anterior portion, was found to have well-developed hooks on the proboscides, and proved to be a scolex of the species *Tetrarhynchus erinaceus* Beneden. (Larval Cestode Parasites of Fishes, pp. 811–812, pl. LXVII, figs. 1–8.)

28. Tautogolabrus adspersus, *Cunner*.

(1) August 10; six, small, 9 to 10 cm. in length; scales of fish found in stomachs of three, others empty, one cyst containing blastocyst and larval Rhynchobothrium. The proboscides were retracted and the specimen was too immature for satisfactory determination. The arrangement of hooks suggested *R. bulbifer*. (Cestode Parasites of Fishes, p. 448; Larval Cestode Parasites of Fishes, p. 793.)

(2) August 16; one, a good-sized specimen; in stomach were bits of sea-weed and a tunicate (*Cynthia partita*). Five or six amber-colored cysts on and in the testes and one of similar nature on liver. These had the general appearance of a cestode cyst, but contained only waxy, degenerate connective tissue. Two of the larger cysts were surrounded with patches of fat cells.

(3) August 26; ten, small; stomach contents not noted. Several small cysts, containing blastocysts and larvæ, on viscera. These appear to be the same as form mentioned in my notes on Cestode Parasites of Fishes, page 794, pl. LXIII, fig. 2.

(4) September 5; five; stomach contents not noted. No entozoa found except in one. Skin with immense numbers of cysts and pigment patches, producing a blue-black color effect which makes the infected fish a very conspicuous object, due to immature distoma. For further details, see page 296 (figs. 76–81).

29. Spheroides maculatus, *Puffer*.

(1) June 13 and 14; one on each date; stomach contents not noted. Specimens collected by Dr. F. P. Gorham.

Numerous distoma from intestine and pharynx, large and small of same species. The largest were from the pharynx, attached to the walls around entrance to the pouch. I refer this distomum to a new species, *D. vibex*. See page 291 for description and general account.

One cestode cyst (*Tetrarhynchus* sp.), a lernean, and one specimen of *Echinorhynchus*, probably *E. acus*, in bottle with the distoma. Mr. Gorham obtained all of these from the pharynx of the fish. The Echinorhynchus is a female; length, 10 mm. The hooks and general proportions, proboscis and body, agree with *E. acus*. The specimen is much smaller, however, than is usual in that species. The lemnisci were indistinctly seen.

(2) July 20; one, small, less than 20 mm. in length. Small distoma, probably young of *D. vibex*, in intestine. Collected by Dr. F. P. Gorham.

30. Mola mola, *Sun-fish*.

July 18; one; alimentary canal filled with digested material of the consistency of thick soup. Vinal N. Edwards tells me he has usually found them "full of jelly-fish." The fish had been taken off No Man's Land by a party from the Marine Biological Laboratory. The external parasites, of which I was told there were many, probably *Tristomum rudolphianum*, had been removed by the capturing party and were not seen by me.

The following entozoa were fonnd:

Dibothrium microcephalum (Ent. Marine Fishes, II, pp. 736–745, pl. II, figs. 5–18), yonng and adnlt in intestine. The largest specimen measured 50 cm. in length and 7 mm. in greatest breadth.

Tetrarhynchus elongatus (Larval Cestode Parasites of Fishes, pp. 812–813, pl. LXVII, figs. 9–12) and possibly another species; enormonsly long blastocysts bnrrowing in the substance of the liver. The enlarged and in some cases globular portion as a rule lay immediately under the serous coat, while the slender, filiform posterior part penetrated the deeper tissne.

Distomum macrocotyle (Trematode Parasites of Fishes, pp. 522–523, pls. XLV, figs. 8–11; XLVI, figs. 1–5), 1 intestine.

D. foliatum (Trem. Par. Fishes, pp. 532–534, pls. XLIX, figs. 3–5; L, figs. 1–3; LI, figs. 1–4), 3, intestines.

D. nigroflavum (Trem. Par. Fishes, pp. 530–531, pls. XLVIII, figs. 8–11; XLIX, figs. 1, 2), 1, intestine.

D. fragile, rather numerous. See page 295 for description.

31. Myoxocephalus æneus, *Sculpin*.

July 23; one; nothing identified in stomach. One small nematode in the body cavity.

32. Prionotus carolinus, *Gurnard or Sea Robin*.

(1) June 5; scolices of *Tetrarhynchus bisulcatus* fonnd by Dr. F. P. Gorham encysted in stomach and intestinal walls; also the same cestode in muscles, but not encysted there.

(2) July 21; one; stomach empty. One larval Rhynchobothrium and one larval Tetrarhynchus found in the body cavity.

(3) July 25; two; stomachs empty. Nematode, immature, on viscera; no other entozoa found.

(4) August 5; three; fish scales in stomach of one, others empty. A few small nematodes found on mesentery. These were immature, rather thick-walled; inner outline of body wall irregular; posterior tip minutely mucronate; intestine brownish; anterior end truncate.

(5) August 24; two; small; stomachs empty. Three distoma from intestine. See page 295 for description (fig. 71).

33. Lopholatilus chamæleonticeps, *Tile-fish*.

September 1; five; stomachs more or less everted and empty; intestines with considerable quantities of partly digested crabs. The fish were taken in 135 meters (75 fathoms) of water south of Newport. The viscera of these fish had been put in formalin and were examined by me September 5. The contents of stomachs and intestines were examined with great care for entozoa. There were found about a half dozen fragments of immature nematodes, evidently taken in with the food; one of them was coiled up, as if it had been encapsuled; one cestode in two pieces, small, could not be identified, but looks like *Tænia*.

One distomum was found which seems to be new. See page 289, *Distomum fæcundum* sp. nov.

34. Opsanus tau, *Toad-fish*.

September 5; two; fragments of fish in stomach. Nematodes in stomach and intestine of each, *Ascaris habena* sp. nov. Eight specimens from both. See page 302 for description.

35. Merluccius bilinearis, *Hake*.

(1) June 4; a vial with specimens collected from a hake by Dr. F. P. Gorham contained parts of pyloric cæca and pieces of gills. On the latter were small cysts not identifiable, apparently very young encysted distoma. One small distomum in the vial. A few immature nematodes obtained from the pyloric cæca. I refer the distomum to *D. ocreatum* Molin provisionally. See below.

(2) July 30; one, young; stomach empty. Fish had died in an aquarium. No parasites found.

(3) August 29; one; stomach contained fragments of fish. Larval cestodes in intestine; numerous cysts (*Rhynchobothrium*) on mesentery and in walls of stomach; small distoma of two kinds found in dish into which contents of intestine had been washed.

Distomum (*Apoblema*) *ocreatum* Molin. See page 298 for further details.

Distomum vitellosum sp. nov. See page 290 for description.

36. Pollachius virens, *Pollock.*

July 14; one; collected by H. M. Kelly.
Ascaris clavata, about 50; stomach. See page 302 for additional notes.
Distomum ocreatum Molin, about 100; stomach. See page 288 for additional notes.
Octobothrium denticulatum Olsson, one; gills. See page 286 for additional notes.
Rhynchobothrium, encysted; mesentery.

37. Paralichthys dentatus, *Summer Flounder.*

(1) July 19; five; stomachs contained only young squid (*Loligo pealii*). Larval cestodes in cystic duct of one, as in squeteague, also many scattered through the chyle of the intestine. Many cestodes (*Tetrarhynchus*) encysted in walls of stomach and intestine of each. A few nematodes, immature, encapsuled in mesentery of each.

(2) July 20; one, large; stomach empty; numerous external copepod parasites on skin; one lernean parasite affixed to palate; an encysted larvæ (*Tetrarhynchus*) with margins of bothria bristly, in submucosa at pyloric end of stomach (*T. robustus*). (Cestode Parasites of Fishes, p. 452.) A few encapsuled nematodes, immature, and an encapsuled *Echinorhynchus* on mesentery. In the latter the body was orange-colored, the head and neck translucent, colorless.

(3) July 22; one; contents of stomach not noted, probably empty; larvæ (*Tetrarhynchus*) in stomach and intestinal wall; and small, immature nematodes in mesentery. See also page 285.

(4) July 23; two; stomach contents not noted, probably empty; one lernean parasite in mouth; cestode cysts in stomach and intestine, as in foregoing; contents of intestine washed out and examined with care; numerous larval cestodes, very small and very active after lying in water for eight hours; same as in foregoing.

(5) July 25; two; stomach contents not noted, probably empty; nematodes on viscera; *Tetrarhynchus* larvæ encysted in stomach wall, rather numerous in vicinity of pylorus.

(6) July 27; one; stomach contents not noted; large number of larval cestodes from cystic duct; small nematode from viscera.

(7) July 28; one; stomach contained young squid (*Loligo*); external copepod parasite on skin of upper side; cystic duct with large numbers of larval cestodes; rather numerous cysts (*Tetrarhynchus*) in submucous coat of stomach.

(8) July 30; two; stomach contents not noted, probably empty; the usual cysts in stomach wall; also numerous cysts under serous coat of stomach. As the latter appeared to be new in this host, the following measurements were taken, in millimeters: Length of cyst, 1.12; shorter diameter, 0.73; length of blastocyst, 0.81; length of larva, 0.52; length of bothrium, 0.18; breadth, 0.18; length of bulbs, 0.35; length of longest hooks, 0.021 to 0.034; bothria slightly emarginate. The hooks are of various shapes and agree with *Rhynchobothrium heterospine.*

(9) August 8; one; stomach contents not noted, probably empty. Nematodes and one *Echinorhynchus* encapsuled in mesentery. The latter had its proboscis partly retracted. When it was placed in the killing fluid the proboscis was gently pulled, when a slender neck made its appearance and the specimen was identified as a young *E. proteus.*

(10) August 16; one; stomach contents not noted, probably empty; the usual cysts in stomach wall; numerous small white cysts under serous coat of stomach, which appear to be same as those recorded under date of July 30 (*Rhynchobothrium heterospine*).

(11) August 25; two; stomachs with young scup (*Stenotomus chrysops*) and young squid (*Loligo pealii*). The commonly occurring cysts were found in the stomach wall. The alimentary canals of these flounders were washed out and search made for small distoma; only one specimen was found, *D. pudens* sp. nov. See under date of September 5 below, also page 290, for description.

(12) August 27; one; stomach contents not noted, probably empty; parasitic copepods on side; one nematode (*Ichthyonema sanguineum*) partly embedded on inside of cheek; see page 304 for the description. A few small distoma (*Distomum dentatum*) were obtained from the intestine; see page 294 for description; also two small distoma, belonging to the subgenus *Apoblema*, which I refer to the species *D. appendiculatum*; see page 289 for description.

(13) September 5; four; stomach contents not noted, probably empty; external copepod parasites on side; a lernean from mouth of one; two immature encapsuled nematodes and several young encapsuled Echinorhynchi, orange yellow, from viscera, identified as *E. proteus*. Numerous distoma (*D. pudens* sp. nov.) See under date of August 25 and page 290 for description. The usual cysts were present in the stomach walls of these flounders; indeed, they appear to be rarely, if ever, absent.

38. Limanda ferruginea, *Sand Dab.*

June 29; one specimen of *Dibothrium punctatum* (Cestode Parasites of Fishes, pp. 430–431); collected by Mr. S. R. Williams from the intestine of the flounder on the above date.

39. Pseudopleuronectes americanus, *Winter Flounder.*

(1) July 25; two, small; stomachs empty; one with six *Echinorhynchus acus* (Entozoa of Marine Fishes, III, pp. 525–528, pls. I, figs. 1–11; VIII, figs. 89–90) in intestine. These were colorless and yellowish white, with the exception of the bursæ of the males, which were bright orange.

(2) Specimens of *E. acus* from intestine; collected by Mr. S. R. Williams June 11 and July 2.

(3) July 25; one; collected by Dr. Ulric Dahlgren; five specimens of *E. acus* from intestine.

(4) September 5; one, small; stomach empty; no entozoa found.

40. Lophius piscatorius, *Goose-fish.*

(1) August 11; one; stomach empty.

Numerous cestode cysts in the mesentery. One of these was opened and the blastocyst yielded a specimen of *Rhynchobothrium speciosum* (Larval Cestode Parasites of Fishes, pp. 801–805, pl. LXIV, figs. 13–14; pl. LXV, figs. 1–7); other species also represented not yet identified. The intestine contained immense numbers of the larval cestodes, small, and like those observed in this host in previous years, with two red pigment patches in the neck. They possess considerable vitality and were active after being in normal salt solution for twenty-four hours. While living, these specimens attached themselves firmly to the bottom of the dish with their suckers, the body floating in the water. Even strong suction with a pipette often failed to dislodge them at first. (Larval Cestode Parasites of Fishes, pp.789–792, pl. LXI, figs. 4–15.) Several nematodes escapsuled in the mesentery and a considerable number, apparently the same species, free in the intestine. These were small and immature.

(2) August 20; one; stomach empty. A number of cestode cysts found in the walls of stomach and intestine, for the most part under the serous coat, but also found involving the deeper layers, some of them even showing more plainly on the inner than on the outer side of the intestinal wall.

Enormous numbers of the small larval form with two red pigment spots in the neck, noted above. No attempt was made to estimate the number. There were certainly many thousands of them within a small area and they occurred for the greater part of the length of the intestine.

Three Acanthocephali, apparently *Echinorhynchus acus* (Entozoa of Mar. Fishes, III, pp. 525–528, pl. I, figs. 1–11, pl. VIII, figs. 89–90), 22, 30, and 31 mm. in length, respectively, all females, found in intestine.

(3) May 28. A few nematodes obtained from the liver of a goose-fish by Mr. Lawrence E. Griffen on above date, similar to those mentioned above—in part at least, probably identical with *Agamonema capsularia* Diesing.

In previous years I have found *Ascaris increscens, Ascaris sp.* (immature), and others probably belonging to the genus Ascaris, but too young for satisfactory determination.

Part II.

Parasitic Copepod from the Squeteague.

[Plate 33, figs. 1-5, U. S. N. M. No. 6507.]

I include in this report notice of a copepod parasite found by Mr. E. E. Tyzzer, July 22, under the skin on the preopercular bone of a squeteague (*Cynoscion regalis*). One specimen was given to me on the date of capture and a sketch was made of it while it was still alive. There was a mass of ova associated with the specimen and a few were attached to the forked tail. Later two other smaller specimens were given to me, which had been found in the same fish in the same position, but on the opposite side of the head. The larger, when viewed from above, had the following characters:

Head bluntly rounded in front, obscurely cordate behind. A single median, orange-colored pigment spot, suggesting in position the eye of Cyclops, was distinctly seen in the living specimen, but can not be made out in the alcoholic specimens. One pair of short, obscurely jointed antennæ were seen protruding beyond the anterior border of the head. The body is not clearly articulate, but about eight constrictions of the body-wall impart an articulate appearance. These constrictions divide the body into about eight segments, including the head. There is, then, first the head, whose breadth equals or even slightly exceeds its length; second, a neck-like segment, narrower than the head, cylindrical, the diameter about three-fourths the length; following this the third division of the body, which is ovoid, enlarged, its diameter more than three times the breadth of the head and its length equal to about one-third the entire length of the animal. Behind the enlarged segment are four cylindrical segments diminishing in diameter and slightly also in length posteriorly. The diameter of the first segment behind the enlarged part is about one-third the diameter of that part; the last, that is, the eighth segment, is anteriorly cylindrical and posteriorly divides into a forked tail, each fork being equal in length to the combined length of the preceding three segments and standing out at nearly right angles to the axis of the body.

From certain faint superficial markings on the dorsum of the enlarged portion there is some reason for believing that it stands for at least three primary divisions of the body. On its anterior end, also, there is a faint constriction, indicated in the sketch, which, if it were of equal distinctness with the other constrictions, would make a short segment, not enumerated in the foregoing. One of the smaller specimens when placed in glycerin showed a corresponding constriction in the intestine at this point. The other did not. Moreover, the intestine in it showed annulations anterior to this which did not have any corresponding annulations in the body-wall.

The color in life was whitish, the intestine dark-brown in its anterior portion. The alcoholic specimens are white, slightly tinged with yellow. The exterior wall, moreover, is separated a little from the parts beneath, especially behind the enlarged portion, so as to look like a thin transparent cuticle. The opaque inner part is studded with sharp-pointed elevations, giving a spinose appearance posteriorly (fig. 5). This appearance is presumably due to the shrinking of the inner part away from the outer wall. The latter is thin, transparent, and very little crustaceous.

On the under side of the head at its anterior end is a circular aperture within which could be distinguished a jointed appendage. This appears to be one, the left, of a pair of maxillae. There appeared to be three joints to this appendage and what was taken to be the basal joint of its fellow. There was some indication of an additional rudimentary pair of appendages in front of these. No anal opening could be made out on the large specimen at first, although a longitudinal mark on the ventral side of last segment, just at the bifurcation, probably represents it. Later it was made out, but was indistinct in the opaque specimen. The two smaller specimens, which were not in first-class condition when they came into my possession, when put in glycerin showed the intestine apparently ending in an anus which was situated on the ventral side of the last segment just at the bifurcation and opening posteriorly.

Dimensions of large specimen in millimeters: Length 13; length of head 0.76, breadth of head 0.78; length of second segment 1, breadth 0.72; length of third segment 4.5, breadth 2.5; diameter of fourth segment 1.5, of seventh 1.3; average length of last five segments 1.2; length of antenna 0.21.

Octobothrium denticulatum Olsson.

[Plate 33, figs. 6-10, U. S. N. M. No. 6508. Bidrag till Skandinaviens Helminthfauna (1876), page 10, Plate I, figs. 13-17.]

A single specimen collected July 14, by Prof. H. M. Kelly, from the gills of the pollock (*Pollachius virens*) agrees closely with Olsson's species, whose synopsis I translate:

"Body depressed, ovate-oblong, tail large, assuming half the length of the animal, canaliculate, each plectanum bearing four pedicels, the pedicels short, cylindrical, their anterior valves extrinsically denticulate. Testes in the postero-median part of the body near the tail. Ova with a filament at each extremity. Length 7 mm., breadth 2 mm."

The following notes were made on the alcoholic specimen: Head bluntly triangular; body lanceolate, slightly constricted behind the head; bothria a little longer than broad, approximating in length to subglobular pharynx. Anterior end for about 0.8 mm. and pedicels white, with tinge of yellow, also white spot in middle and white along mid line near anterior end; remainder of body dark brown. This for the dorsal side; ventral side same, but paler on the brown parts, and the mid line is white from the anterior end to about the level of the second pair of pedicels. Each pedicel appears to expand into a two-valved disc at the extremity, the valves being supported by a chitinous framework. There is a cluster of denticulate papillæ on the anterior outer fourth of each disc, on what, when it is expanded, is its dorsal surface. Two dark-brown ova lay on the median line about 1 mm. back of the pharynx. These were oblong and had a slender filament at each end. The character of the filaments could not be made out exactly without mutilating the specimen.

Dimensions of alcoholic specimen in millimeters: Length 8; breadth, anterior 0.39, in front of pedicels 2, including pedicels 3.5; diameter of single disc 0.65; breadth of one of anterior bothria 0.14, length of same 0.16; breadth of pharynx 0.16, length of same 0.17; length of ovum not including filaments 0.19, breadth of same 0.07; length of single filament 0.14.

The cirrus, which is armed with a circle of fourteen bifurcate hooks, opens on the mid-ventral line 0.17 mm. back of the pharynx. The length of these hooks is about 0.02 mm. The arrangement of the reproductive organs could not be made out. The vitellaria fill up the greater part of the body, extending from the extreme posterior end, even going a short distance into the bases of the posterior pedicels, to within less than 1 mm. of the anterior end. The testis and ovary could be seen lying a little in front of the anterior pedicels, but they were so much hidden by the voluminous vitellaria that their outlines could not be made out.

Epibdella bumpusii sp. nov.

[Plate 34, figs. 11-15, U. S. N. M. No. 6509.]

My attention was first called to this beautiful and interesting form by Dr. Hermon C. Bumpus. Several specimens were obtained on August 18 from the exterior of the stingray (*Dasyatis centrura*).

Body flat and leaf-like, smooth, ovate, slightly constricted behind the anterior suckers, bluish-white and transparent. Anterior suckers crossed by about 22 ribs. Posterior sucker attached by pedicel at posterior margin of body, elliptical, the length slightly exceeding the breadth, armed with four hooks; the two anterior hooks straightish on the inner and convex on the outer margins, as seen in dorso-ventral view; the two posterior hooks longer, more slender and arcuate, being curved toward the lateral margins. Pharynx subglobular. Testes two, about the middle of the body, on opposite sides of the median line, subspherical. Ovary a short distance in front of testes, triangular in outline. Vitelline reservoir immediately in front of ovary and a little toward the left. Reproductive apertures on left side of neck at marginal notch. Cirrus, uterus, and vagina open near together, the former being the most anterior and the others following in the order named. Larger part of the body occupied by the vitelline glands. Ova tetrahedral, with long, slender filament, ejected from uterus as fast as made.

Dimensions of living specimen, in millimeters: Length 12.5, breadth 8.35, breadth of posterior sucker 4.4, length of anterior sucker 1.25, breadth of same 0.31, breadth of pharynx 0.71. Other specimens were somewhat smaller. In a specimen mounted in balsam the length of the ventral sucker is 3.2, the breadth 2.4; the length of the longer hooks is 0.85, of the shorter 0.6. The length of the body of this specimen, exclusive of the ventral sucker, is 8, breadth 4.5.

Although somewhat aside from the main purpose of this paper, I append a few observations on the process of ovulation in this species, first as seen in operation in the living worm, and second as confirmed by a study of serial sections.

1. *The process of egg-making in the living worm.*—One of the lobes of the yolk reservoir appears to empty itself suddenly by a short duct into the common duct immediately in front of the ovary. Thence the mass of coarse granular yolk is seen to pass rapidly forward along the duct to the capsule mold, where it is shaped into a tetrahedral form by the muscular walls of the mold. As soon as the mass of yolk reaches the mold the passage closes just behind the mold, where a comparatively solid base is formed, against which the mass of yolk is hammered into shape by the walls of the mold. At the same time the capsule is built around the mass of yolk. The material of which the capsule is formed appears to be secreted by what was interpreted to be the shell gland, which was situated about midway between the mold and the ovary.

It was not clearly evident where the slender filament was formed, although I thought I saw it lying in the spiral common duct, between the shell gland and the mold, just before the discharge of an egg. When the capsule is nearly finished a very small fine granular mass makes its appearance suddenly in the common duct at about the level of the shell gland. This mass, apparently injected into the common duct from the dorsal side, travels rapidly along the common duct, and as soon as it reaches the mold the completed egg is ejected forcibly by powerful contractions of the muscular walls of the mold. The duct through which it passes lies between the cirrus and the seminal receptacle. When an egg is not in transit this uterine duct is difficult to see, the walls being apparently nearly approximate.

The rush of yolk from the yolk receptacle to the common duct probably creates sufficient suction to draw a germ cell from the short communicating duct. Germs were distinctly seen in this duct and they were also seen to be set into oscillatory vibration when a mass of yolk was passing, but the yolk mass itself concealed the proximal end of the communicating duct, so that no germ cell was actually seen to leave the duct to join the yolk mass, although when the latter reached the egg mold, a germ cell could occasionally be seen among the coarse yolk granules. The fine granular mass which joined the egg just before it was ejected was inferred to come from the seminal duct. This inference is apparently confirmed by structures revealed in serial sections as described below.

Egg-making would proceed actively for some time, 10 minutes or more, then would follow a short period of rest. Unfortunately the time occupied in making an egg was not noted until the specimen had been under observation for 2 or 3 hours and had presumably lost much of its vitality. When noted the period occupied from the time when a mass of yolk left the reservoir until it was ejected as a completed capsule was about 40 seconds.

2. *Confirmation of some of the above-mentioned inferences.*—Sections, both transverse and horizontal, were made of this interesting worm. The results were highly satisfactory, but the anatomical details are so numerous as to be altogether out of place in this report. I shall mention only certain details of structure which explain some of the phenomena of ovulation narrated above.

The duct which leads from the yolk reservoir passes dorsally (fig. 14, *yd*), hence can not be seen plainly, either in dorsal or ventral view, in the living specimen. The duct from the germ gland also has its outlet dorsally, and the two connect in such a manner that when a mass of yolk rushes along the yolk duct and into the common duct, a suction would be created which would tend to draw a germ from the germ duct. While the germ duct is spacious at its beginning in the germ gland, which feature, indeed, could be seen plainly in the living specimen, where numerous ripe germs could be seen oscillating every time a charge of yolk passed toward the shell mold, the duct grows narrower distally, and at a short distance from the point of union with the yolk duct is but little wider than the diameter of a single germ. Since the amount of yolk which is necessary for a single egg is doubtless regulated by reflex nervous action, the whole apparatus has become adjusted with wonderful nicety, the several parts to each other, so that, when normal conditions prevail, just enough suction is created by the charge of yolk to draw a single waiting germ cell from the germ duct.

Another fact demonstrated by serial sections is that at a point but a short distance from the junction of germ duct with yolk duct, the common duct is joined by a small duct which was traced to the seminal receptacle. The latter is a thick-walled, muscular organ, lined with what in the sections look like cilia. It lies to the left of the other reproductive organs and has its external aperture, like them, at a notch on the left side of the head. The seminal duct is very much smaller than the vas deferens and does not stain so deeply with carmine. The vas deferens in these sections is very conspicuous and can be traced with ease from the testes forward in a somewhat tortuous course to the seminal vesicle at the base of the cirrus pouch.

This and kindred forms would well repay careful study and are commended to anyone who is in search of a thesis for research work.

Distomum ocreatum Molin.

[Plate 35, figs. 16-24, U. S. N. M. No. 6510.]

Two lots of distoma, the first collected July 14 by Prof. H. M. Kelly from intestine of the pollock (*Pollachius virens*), the second collected August 29, from the hake (*Merluccius bilinearis*), agree closely with the species obtained from the blue-fish. (Notes on Trematode Parasites of Fishes, Proc. U. S. National Museum, vol. XX, pp. 514-515, pl. LII, fig. 13.)

For purposes of comparison I give the following measurements:

Measurements.	No. 1.	No. 2.	No. 3.
Length, including appendix	3.66	1.36	1.26
excluding appendix	2.88	1.26	1.06
Breadth, anterior	0.40	0.19	0.19
median	1.05	0.37	0.33
posterior	....	0.14	0.10
Diameter of oral sucker	0.30	0.18	0.15
ventral sucker	0.34	0.20	0.15
Length of pharynx	0.17	0.10	....
Breadth of pharynx	0.14	0.10	....
Longer diameter of ovum	0.025	0.026	0.026
Shorter diameter of ovum	0.013	0.014	0.014

No 1 is from *Merluccius*, the measurements made on a living specimen slightly compressed. Nos. 2 and 3 are from *Pollachius*, measurements made of specimens mounted in glycerin.

Among the specimens from the hake were two sizes; the measurements given are from one of the larger specimens. A smaller specimen in life had the following dimensions in millimeters: Length 1.63, breadth of anterior sucker 0.20, breadth of posterior sucker 0.18, longer diameter of ovum 0.025, shorter diameter 0.013. The appendix was retracted. Another specimen measured 1.92 in length, the appendiculate portion measuring 0.35 in length. The bodies of the smaller specimens were much contracted and the appendages retracted. Sections of the smaller specimens show that the seminal vesicle is dorsal to the acetabulum and situated rather more toward the posterior than the anterior border. The prostate is large and lies dorsal and antero-dorsal to the acetabulum.

Only one large specimen was found among the preserved specimens. It was sectioned, but since it had been subjected to pressure during the preliminary examination it was found to be somewhat distorted. The seminal vesicle is at the anterior edge of the acetabulum and there is a conspicuous prostate behind the pharynx. Sections of the smaller specimens showed that the excretory vessels unite in front of the testes, which, as in the specimens from the pollock, are but a short distance back of the acetabulum. The branches of the intestine extend into the appendix. After lying in water for some time some of these worms lost the sharply serrate margins, which is a characteristic feature, due to the regular transverse plications of the cuticle, and in some of the mounted specimens these transverse striæ no longer appear.

While examining some of the smaller specimens at the time of collecting, numerous spherical masses were seen, which at first were taken to be ova. Further considerations proved them to be concentric in structure and to lie in the excretory vessels. They were observed in other distoma and appear to be solid excreta. Search was made for these spherical bodies in sections, and in the excretory vessels some were found which appear to be identical, although much smaller.

While these specimens, which I have identified as *D. ocreatum* Molin, agree closely with published descriptions of that species, especially those of Olsson, there is one point which I have not been able to verify with entire satisfaction. The cirrus of *D. ocreatum* is papillose. The cirrus in the specimens which I have examined appears to be minutely papillose, but none were seen with satisfactory distinctness. The reproductive aperture is at the under side of the mouth.

The trilobed character of one of the two vitellaria is clearly shown, and the size of the ova is substantially the same in all. At the same time sufficient diversity is shown in these several varieties to make it desirable that those forms belonging to the subgenus *Apoblema*, which have equal or nearly equal suckers, be revised with care.

Distomum appendiculatum Rudolphi (?).

[Plate 36, figs. 25, 26, U. S. N. M. No. 6511.]

Two small distoma, associated with *D. dentatum*, from the flounder (*Paralichthys dentatus*), belong to the subgenus *Apoblema* and appear to be near *D. appendiculatum*. The specimens, while quite small, are adult, each containing numerous ova. Collected August 27.

The following description is based on a mounted specimen: Body cylindrical, crossed by fine transverse striæ about 0.005 millimeter apart. These striæ are sharp and clear and make a regular serrate outline at the margins; neck short, conical, concave beneath; mouth subterminal; acetabulum at base of neck about twice the diameter of the oral sucker, both suckers nearly globular; seminal vesicle a short distance back of acetabulum situated toward dorsal side; between it and the acetabulum is the large prostate and cirrus pouch. The external reproductive aperture is on the midventral line very close to the mouth; cirrus smooth. The testes are two small subglobular bodies about 0.17 mm. behind the acetabulum, ventrally placed and lying diagonally near together on the median line. The vitellaria are two small but well-defined bodies lying ventrally a little toward the right, their front margins about half way between the acetabulum and the end of the body proper; the right lobe is subglobular, the left somewhat three-lobed. The folds of the uterus do not extend into the appendix; ova numerous, lying among the reproductive organs from behind the testes to the acetabulum; ovary globular, lying just in front of the vitellaria slightly dorsal to and touching them.

Dimensions of mounted specimen, in millimeters: Length with appendix 1.13, length without appendix 0.92, greatest diameter 0.25, diameter of oral sucker 0.065, diameter of acetabulum 0.12, length of pharynx 0.05, diameter of pharynx 0.04, longer diameter of ova 0.027, shorter diameter of ova 0.014.

It will be noticed that while the proportions of the suckers are those of *D. appendiculatum* the character of the vitellaria shows a dissimilarity to that species.

Distomum fœcundum sp. nov.

[Plate 36, figs. 27-35; Plate 37, figs. 36, 37, U. S. N. M. No. 6512.]

On September 1 the viscera of five tile-fish (*Lopholatilus chamæleonticeps*) taken in 75 fathoms of water, south of Newport, R. I., were placed in formalin. On September 5 I examined these viscera for entozoa, finding but few, and only one speciman of Distomum.

The specimen being too thick to permit of a satisfactory examination of the internal structure, it was cut into transverse sections. A study of these yielded such interesting results that I feel justified in recording the following description: Body unarmed, smooth save for transverse wrinkles probably due to contraction, thick, bluntly rounded in front, squarish posteriorly; neck slightly excavate beneath; mouth subterminal, circular; acetabulum much larger than oral sucker, sessile, prominent, its aperture a transverse slit; pharynx subglobular; œsophagus very short; branches of intestine simple, extending to posterior end; genital aperture in front of acetabulum a little to right of median line; cirrus and pouch for the greater part dorsal to acetabulum, seminal vesicle dorsal on left side just in front of ovary, vas deferens accompanied by prostate from seminal vesicle to cirrus also dorsal; ovary dorsal back of posterior third on median line; testes two, transverse, the right a little in advance of the other, following the ovary posteriorly, but situated more ventrally than ovary.

In sections proceeding from the head the right testis appears soon after the ovary is first seen, and continues to show in sections after the ovary has disappeared. The shell-gland is ventral to the ovary. Vitellaria not abundant in this specimen, which is adult, situated along the dorso-lateral regions of the body from the testes to the posterior edge of the acetabulum. The excretory vessel was traced from the terminal pore, as a single narrow median canal, to a point in front of the ovary, where it divides, the two branches passing one on either side of the acetabulum ventral to the intestine. The most conspicuous organ in this specimen is the uterus. Its folds fill the body from the posterior end to the acetabulum. Both behind and in front of the ovary and testes the uterus occupies the whole cavity, save the small place occupied by the intestinal branches and excretory vessels. The ova, of which there are immense numbers, are small, oblong-elliptical in outline, with thin shell. The contents of a great many of them were stained deeply with carmine. Many of them were broken open in the same manner at one end as if a natural line of cleavage existed there, causing a terminal cap-like part of the shell to separate. The cells which line the intestinal tract are long and project into the lumen with their bluntly rounded and slightly enlarged ends.

Dimensions in millimeters: (1) Specimen entire in oil of cedar. Length 2.75, breadth through

anterior sucker 1, breadth through acetabulum 1.25, breadth at posterior fourth 1.4, distance between suckers 1.1, thickness behind acetabulum 1.1, thickness at acetabulum 1.5; (2) from sections, transverse diameter of oral sucker 0.68, vertical diameter of same 0.47, transverse diameter of pharynx 0.34, vertical diameter of same 0.28, length of same (estimated) 0.28, transverse diameter of acetabulum 1.03, vertical diameter of same 0.65, greater diameter of ova 0.031 to 0.041, lesser diameter of ova 0.017, transverse diameter of ovary 0.48, vertical diameter of same 0.24, length of same (estimated) 0.30.

Some of the details of structure are shown in the sketches, figs. 29–37.

Distomum vitellosum sp. nov.

[Plate 37, figs. 38, 39, U.S.N.M. No. 6513.]

Three small distoma associated with others referred to *D. ocreatum* Molin, in the hake (*Merluccius bilinearis*), collected August 29, are here described. They were distinguished from the others at the time of collecting by their slender conical necks, very prominent acetabulum, relatively large ova, and having the posterior part of the body filled with subangular vitelline masses.

The species is probably new. It would seem to be a member of a group of species of which *D. umbrinæ* Stossich, *D. obovatum* Molin, and *D. mormyri* Stossich are representatives. The characters, so far as they can be made out from my specimens, are: Body smooth, subcylindrical; neck short, slender, conical, very contractile in life, in preserved specimens arched above, concave and hollowed out beneath; mouth subterminal, aperture transverse; pharynx, immediately following oral sucker, elongated; œsophagus not made out, but either none or very short; branches of intestine simple, not spacious, extending to near the posterior end; acetabulum much larger than oral sucker, prominent, aperture contracts to small, transverse opening with puckered margins, situated about anterior third in preserved specimens. Aperture of reproductive organs in front of acetabulum, on left of median line; testes two, moderately large, median, approximate, and situated near posterior end; ovary in front of anterior testis and touching it, lying on median line, but a little toward the right; vitellaria consisting of numerous rather large subangular masses, which fill the body behind the testes and extend along the sides as far forward as the acetabulum; ova not numerous and rather large, lying between ovary and acetabulum.

Dimensions in millimeters: (1) Of a specimen in glycerin, length 1.42, diameter of oral sucker 0.08, diameter of acetabulum 0.25, longer diameter of ova 0.052, shorter diameter of ova 0.031; (2) of a specimen in balsam, length 0.88, diameter of anterior sucker 0.10, diameter of acetabulum 0.17, greatest breadth of body 0.25, length of neck 0.22, longer diameter of ova 0.058, shorter diameter of ova 0.034.

Distomum pudens sp. nov.

[Plate 37, figs. 40–47, U. S. N. M. No. 6514.]

Certain distoma from the common flounder (*Paralichthys dentatus*) collected September 5 were thought at first to be identical with *Distomum* sp. from the same host, described on page 296; but when examined more closely were found to be different. The alimentary canals of four flounders were washed out and, after repeated washing and decanting, a large number of distoma were obtained. These are of various shapes and sizes, but appear to belong to the same species. The largest when living measured from 2.7 to 3.7 mm. in length, with maximum breadth of about 0.8 mm. One of the smaller specimens measured 1.2 mm. in length and 0.42 mm. in breadth.

The following description is based on preserved material: Body smooth, ovate to linear oblong, somewhat depressed; neck variable, conical, tapering to mouth, or often shortened by inversion of anterior end; mouth terminal, unarmed; oral sucker nearly circular in outline in a few cases, but in most considerably broader than long; acetabulum nearly circular in outline, i. e., when viewed either from the dorsal or ventral side, and considerably larger than the oral sucker, situated not far from the anterior fourth; pharynx pyriform, with the posterior end the larger, proportions not uniform. In some cases the length is greater than the breadth, in some it equals the breadth, and in some it is less than the breadth; separated from the oral sucker by a distance equal to a little more than its own length and from the intestinal rami by a distance less than half its length. These proportions are for a specimen in which the neck is extended. When the anterior end is inverted, or even slightly contracted, the pharynx may follow the oral sucker very closely and appear to open directly into the intestinal rami. The walls of the intestine are very thin; the intestinal rami are simple and extend to the posterior end of the body. The excretory vessel was seen to be spacious and thin-walled at the posterior end, but was not seen in anterior part of the body. It should be noted that the specimens had lain overnight in water before they were placed in killing and hardening fluid.

Testes two, rather large, median, approximate, anterior testis nearly circular in outline when seen from dorsal or ventral surface, the posterior testis a little longer than broad; seminal vesicle large, situated toward the right side at base of cirrus pouch, in which it is partly included, behind acetabulum, but passing, with cirrus pouch dorsal, to acetabulum to the right, the cirrus, which is a conspicuous organ, opening beside the uterus just in front of the acetabulum; spines were noted in sections of what in an everted cirrus would be the somewhat bulbous base; ovary globular, much smaller than testis, approximate to anterior edge of anterior testis and on the right of the median line; the vitellaria consist of numerous small bodies, which lie along the lateral margins and at the posterior end; they extend laterally into the neck as far as pharynx; uterus from genital aperture passes back on left side of acetabulum dorsally to folds of uterus, which lie between the anterior testis and acetabulum and contain rather large, not numerous ova.

A large number of measurements were made of mounted specimens, and considerable variation was found in the proportions of even such usually constant organs as the suckers and pharynx. Dimensions in millimeters: (1) Of sectioned specimen, length 2.74, greatest breadth 0.57; oral sucker, length 0.14, breadth 0.18; acetabulum, length 0.21, breadth 0.21; pharynx, length 0.16, breadth 0.13. (2) Of a mounted specimen, length 1.6; oral sucker, length 0.076, breadth 0.114; acetabulum, length 0.155, breadth 0.155; pharynx, length 0.086, breadth 0.076. Longer diameter of ova in sectioned specimen 0.055, shorter diameter 0.035; ova in a specimen cleared up in acetic acid measured 0.069 in the longer and 0.035 in the shorter diameter.

These specimens agree very closely with *D. fasciatum* Rudolphi, but differ in the ratio of oral sucker to acetabulum. In *D. fasciatum* the acetabulum is double the diameter of the oral sucker; furthermore, the œsophagus, i. e., that portion of the alimentary canal between the pharynx and the intestinal rami, is represented as longer than the pharynx, and the pharynx as following the oral sucker directly. In *D. pudens* the diameter of the acetabulum, while greater than that of the oral sucker, is not twice as great, and the pharynx is followed by a very short œsophagus, while it is separated from the oral sucker by a distance about equal to its length, except in cases of inversion of anterior end.

Distomum vibex sp. nov.

[Plate 38, figs. 48–51, U. S. N. M. No. 6515.]

The following description is based on alcoholic specimens collected by Dr. F. P. Gorham, June 14, from the smooth puffer (*Spheroides maculatus*), pharynx and intestine: Body unarmed, sublanceolate, thick, convex above; neck concave beneath; acetabulum much larger than mouth; aperture transverse, in most cases retracted, with part of the adjacent body wall drawn into its interior; mouth subterminal, aperture circular; pharynx subglobular, contiguous to oral sucker; œsophagus short; intestinal rami simple, extending to posterior end of body; excretory vessels large; testes two, lateral, behind acetabulum and in front of the folds of the uterus; ovary subglobular, in front of testes, dorsal; vitellaria lateral and posterior, extending forward to the acetabulum; genital aperture behind the pharynx near the median line.

This species resembles *D. fellis* Olsson, but differs especially in the position of genital aperture. The specimens vary from 1.25 to over 6 mm. in length. Many of the larger ones are transversely wrinkled. The smaller ones are smooth, and all present a plump appearance. Many of them had become fastened together, probably at the time of immersion in the killing fluid, the acetabulum of one adhering so strongly to another as to pull a part of body into a prominent knob.

The following gives dimensions, in millimeters, of a large and small specimen, alcoholic·

Measurements.	Large specimen.	Small specimen.
Length	6.00	1.34
Diameter at oral sucker	1.00	0.37
Diameter at acetabulum	1.80	0.60
Greatest breadth	2.60	0.70
Breadth of oral sucker	0.55	0.33
Length of oral sucker	0.53	0.32
Breadth of acetabulum	0.98	0.66
Length of acetabulum	0.89	0.50
Distance between suckers	1.60	0.55
Greatest thickness of body	2.00	0.61
Longer diameter of ovum	0.059	....
Shorter diameter of ovum	0.029	....

Sections of both the large and the small specimens were made, and while it does not enter into the plan of this paper to give histological details, the following anatomical details may be here recorded for purposes of identification: The cuticle is thick, particularly its inner layer, which presents a crenulate outline. Both longitudinal and circular muscles strongly developed, especially the former, and in the neck transverse fibers are very abundant. The submuscular cell layer is very conspicuous. The pharynx is about half the length of the oral sucker, and opens into the intestinal rami by a very short œsophagus. The acetabulum is strongly developed, and evidently functions as a powerful suctorial organ. In all the specimens sectioned it had drawn in a part of the tissues constituting the ventral portion of the base of the neck, while the cavity of the acetabulum contained material which appeared to be pieces of the intestinal mucous membrane of the host. The branches of the intestine lie dorso-laterally, and reach to the posterior end of the body. On account of the state of contraction of the body, the intestinal walls are much convoluted. The cells lining the intestine are large and the ends turned toward the lumen are swollen and stain very slightly with carmine.

The excretory vessels were traced forward to the oral sucker and back to the posterior end, where they unite. The vessels are large, their walls thin, granular inner surface staining deeply with carmine. Near the posterior end the walls become somewhat thickened and appear much folded. The ovary is in front of testes, toward the dorsal side and close behind the acetabulum. Some of the sections indicate an obscurely lobed structure. The shell gland lies on the ventral side of the ovary and immediately behind the acetabulum. The uterus, beginning at the shell gland just behind the acetabulum, fills the posterior part of the adult body with its voluminous folds. It leads forward on the dorsal side of the acetabulum, and in front of that organ passes ventrally beside the cirrus pouch, the external genital aperture being on the ventral side of the neck, a little to the right of the median line in one specimen, a little to the left in another, and, as near as could be determined in these highly contracted specimens, approximately about the anterior third of distance between the two suckers. The testes are two, laterally placed behind the ovary and ventrally, and near enough so that some of the transverse thin sections of the body passed through both the testes and the ovary.

The seminal vesicle lies immediately in front of the acetabulum. It is inclosed in a spherical muscular sac, but it and the vas deferens, cirrus, and prostate gland all are inclosed in a special sac. This is partly shown in the sketch, fig. 49, *p. sv.* No posterior seminal receptacle was made out.

The vitelline glands are conspicuous voluminous organs lying laterally and posteriorly rather more ventral than dorsal. They appear to consist of numerous branching glands which extend forward to the posterior edge of the acetabulum. In sections stained lightly with carmine these organs are beautifully differentiated as golden-brown bodies with parts stained red with the carmine. Both ovary and testes stain strongly in carmine.

Distomum pyriforme sp. nov.

[Plate 38, figs. 52-59, U. S. N. M. No. 6516.]

These distoma were found on four occasions, August 10, 19, 22, 25, in enormous numbers in the pyloric cæca of the rudder-fish (*Palinurichthys perciformis*).

Body very slightly compressed, of various shapes, but usually elliptical or pyriform in outline, armed with low, flat, rounded, scale-like spines. Neck in some slightly extended; in others the oral sucker was retracted (fig. 56). Mouth subterminal, orbicular. When the worm is extended so as to give a favorable view the oral sucker is slightly elongated and separated from the pharynx by a short œsophagus. The latter, of course, is difficult to make out in contracted specimens. Acetabulum a little broader than long, about equaling the oral sucker and situated about the middle of the length of the body. Intestinal branches conspicuous, straight, reaching to the posterior end of the body. Testes two, nearly globular, but breadth slightly greater than length in elongated and considerably greater in contracted specimens, situated well toward the posterior end, close together, one immediately in front of the other. Cirrus pouch elongated, on right side of acetabulum opening in front of the same; cirrus spinose. Ovary small, round, situated in front of the testes near the seminal vesicle, dorsal, and a little toward the right and close to the acetabulum. Vitellaria voluminous, filling the greater part of the body, especially at the posterior end and along the lateral margins as far forward as the acetabulum. Uterus evidently short, ova very few and relatively large, lying between ovary and acetabulum and equaling in length the diameter of that organ.

The following table gives the dimensions in millimeters:

Measurements.	No. 1.	No. 2.	No. 3.
Length	0.31	0.35	0.26
Breadth	.19	.12	.18
Length of oral sucker	.06	.048	.052
Breadth of oral sucker	.06	.041	.052
Length of acetabulum	.055	.038	.048
Breadth of acetabulum	.062	.041	.052
Length of pharynx	.031	.035	.038
Breadth of pharynx	.031	.027	.031

No. 1 was a living specimen, slightly compressed; Nos. 2 and 3 were mounted in balsam. A specimen free in sea water measured 0.36 mm. in length contracted and 0.57 mm. when extended. The ova measured 0.055 and 0.031 mm. in the two principal diameters.

The following measurements of living specimens show the various shapes assumed by these worms:

Length	0.26	0.36	0.33	0.21	0.25	0.34	0.16	0.45
Breadth	0.26	0.17	0.21	0.11	0.14	0.09	0.10	0.17

Sections were made of some of the pyloric cæca and revealed numerous distoma embedded in the contents of the cæca (fig. 52). Spherical bodies with a concentric structure were seen lying in the excretory vessel. These masses were not of uniform size; the largest measured 0.01 mm. in diameter. They appear to be solid excreta. They are much smaller than the ova and moreover are spherical. In these sections it was seen that the oral sucker and acetabulum are of substantially the same size. One of the larger specimens, which lay in a favorable position, yielded the following measurements (in millimeters) of these parts: Diameter of oral sucker, 0.07; of acetabulum, 0.07; diameter of pharynx, 0.04; length of body, 0.35; breadth, 0.24.

A large portion of the preserved specimens have the anterior end of body inverted. There is thus the greatest variety of outline exhibited by these specimens, long and short oval, sublinear, elliptical, and pyriform, the latter in some form or other perhaps predominating. The excretory vessel appears to be large and was seen to expand into a spacious posterior area in some instances (fig. 55). In the sections the cirrus was seen to be spinous, and the seminal vesicle and prostate were relatively large. The genital aperture is in front of the acetabulum and apparently near it. The ova are few, usually three or four—in one case six were seen—but as compared with the size of the worm are very large.

No attempt was made to estimate the numbers of these distoma in a single host. In the first instance the pyloric cæca were seen to be minutely punctured with dark specks. When they were placed in a small dish of sea water and examined with a hand lens, immense numbers of small distoma were seen on the pyloric cæca. The sketch of a part of a section of the pyloric cæca (fig. 52) gives an imperfect idea of the great numbers of these parasites. When it is remembered that this is what is shown in a very thin section and that a long series of sections revealed a similar degree of infection throughout the cæca, it may be inferred that the vitality of the host is affected seriously by their presence.

Distomum areolatum Rudolphi.

[Plate 39, figs. 60–63, U. S. N. M. No. 6517.]

Some small distoma, found in a dish in which viscera of the white perch (*Morone americana*) had been lying, are referred, not without some doubt, to this species. The following description is based on a mounted specimen. Body covered with short, flat spines, which appear slender on the margins, probably because there seen on edge. The spines become somewhat scattered posteriorly, but with care may be traced nearly if not quite to posterior end. The body is depressed, ovate, and broadest toward posterior end. The anterior sucker is unarmed, ovate, with circular aperture, subterminal and a little larger than the acetabulum. The latter is sessile, broader than long, and situated about the anterior fourth of the body. Pharynx oblong, shorter than the oral sucker. Œsophagus very short, shorter than pharynx. Branches of the intestine simple, extending nearly to the posterior end. Excretory vessel spacious, at posterior end of the body. Testes, two rather large bodies placed side by side on opposite sides of the median line, with their anterior borders about the middle of the body. The cirrus pouch lies back of the acetabulum and to the right.

The reproductive aperture is in front of the acetabulum. The ovary is subglobular and lies on the left of the median line and is separated from the acetabulum by the uterus with a few—three or four—large ova, and the shell gland. The latter lies just back of the acetabulum. On the right side of the median line and at about the same level as the ovary is the posterior seminal receptacle. Just back of the seminal receptacle and ovary, and lying across the median line, is a lozenge-shaped mass of vitelline substance, apparently a yolk reservoir, with ducts leading to the right and left to the voluminous vitelline glands. These glands occupy the lateral margins of the body from the posterior end to the pharynx.

Dimensions in millimeters: (1) In sea water, length variable, but from 0.7 to 0.9; breadth 0.4; oral sucker, length 0.10, breadth, 0.12; acetabulum, length 0.10, breadth 0.09; ova, longer diameter 0.11, shorter diameter 0.07. (2) Specimen mounted in balsam, length, 1.3; greatest breadth 0.64; diameter of oral sucker 0.17; diameter of acetabulum 0.13; length of pharynx 0.28; breadth of same, 0.25; distance between suckers (margins) 0.14. In one case where the acetabulum was 0.10 long and 0.11 broad, an ovum measured 0.117 and 0.076 in the two principal diameters.

Distomum dentatum sp. nov.

[Plate 39, figs. 64–67, U. S. N. M. No. 6518.]

A few small distoma from the flounder (*Paralichthys dentatus*), resembling in many important particulars the species which I have called *D. tenue* (Proc. U. S. Nat. Mus., vol. XX, p. 535, pl. LII, figs. 2–8), are here included.

The following description is based mainly on specimens mounted in balsam: Body somewhat depressed, increasing in breadth toward posterior end, the proportions varying with different stages of contraction, but posterior end usually bluntly rounded, greatest diameter usually at the posterior testis; neck short, conical, cylindrical in front, somewhat depressed at base; neck and body covered with short, subtriangular, scale-like spines, which are densely placed anteriorly, but become scattering at posterior fourth and very sparse at posterior end; ventral sucker sessile, larger than oral sucker, nearly circular in outline, with transverse aperture, situated about the anterior third, though in some cases where the neck was contracted the suckers were closer together and the acetabulum was then in advance of the anterior third; mouth terminal, surrounded by double circle of straightish spines, about 24 in each circle, the spines of one circle alternating with those of the other; the oblong pharynx is separated from the oral sucker by a distance approximating its own length, lies close to the front edge of the acetabulum, and opens directly into the intestine.

The branches of the intestine extend to the posterior end of the body. The cirrus pouch, with the inclosed seminal vesicle, lies behind the acetabulum and a little to the right. The cirrus passes along the right dorsal edge of the acetabulum, while the distal end of the uterus passes on the dorsal left edge of the same, both coming together at the reproductive aperture in front of the acetabulum, about on the median line. Behind the cirrus pouch and in front of the ovary is the uterus, containing a comparatively small number (40 estimated in one) of ova. The ovary lies a little to the right of the median line, immediately in front of the anterior testis, appearing somewhat triangular in outline. The testes are two, large, quadrangular in outline, broader than long, median, approximate, the junction between them not far from posterior third of the body. The vitellaria are very abundant, massed posteriorly, along the lateral margins even into the neck, and around the periphery of the body over the other organs.

Dimensions, in millimeters:

(1) Living specimen: Length 1.14, anterior diameter 0.14, median breadth 0.37, diameter of oral sucker 0.08, diameter of acetabulum 0.14, longer diameter of ovum 0.07, shorter diameter of ovum 0.03.

(2) Specimen mounted in balsam: Length 1.85, anterior diameter 0.17, greatest breadth 0.64, diameter of oral sucker 0.14, diameter of acetabulum 0.20, length of pharynx 0.14, diameter of pharynx 0.10, length of anterior testis 0.21, length of posterior testis 0.28, breadth of each testis 0.31, longer diameter of ovum 0.06, shorter diameter of ovum 0.03, length of longest oral spines 0.04.

When these specimens are compared with *D. tenue*, besides being considerably smaller they are relatively broader and much more appressed. The number of oral spines is different, although this difference should not be made much of, since observations on a great number of specimens are needed to determine what variations. if any, occur in this respect in these species.

Distomum fragile sp. nov.

[Plate 39, figs. 68–70, U. S. N. M. No. 6519.]

Several small distoma were found in the intestines of a sun-fish (*Mola mola*) on July 18. On account of their inconspicuous size, and because of the large amount of other material which was collected at the same time, these specimens were not given as much attention at the time of collecting as they deserved. Upon going over the preserved material I find that it is not in perfect condition, the delicate necks of the specimens having broken in every case.

The following description is based entirely on preserved material: Body unarmed fusiform from acetabulum back, depressed; neck elongated, slender, cylindrical, slightly enlarged at mouth. Acetabulum a little larger than mouth, subglobular, at base of neck sessile; mouth terminal or nearly so; pharynx subglobular, situated a distance equal to twice its length or more behind the posterior edge of the oral sucker, followed by a slender œsophagus; intestinal crura simple, beginning in the neck about half way between the pharynx and acetabulum, extending to near the posterior end of the body; testes two, median, approximate, situated near the posterior end of the body, a little longer than broad; ovary subtriangular in outline, lying immediately in front of the anterior testis and a little to the right; cirrus and cirrus pouch immediately in front of the acetabulum and to the left; vitellaria very abundant, appearing in subangular masses at posterior end and along dorsal and lateral regions of the body to and even in front of the acetabulum; uterine folds between acetabulum and ovary; ova relatively large and in moderate number.

Dimensions of mounted specimen, in millimeters: Length 1.78, diameter of anterior sucker 0.10, diameter of neck behind mouth 0.07, diameter at acetabulum 0.24, greatest diameter 0.33, distance of acetabulum from anterior end 0.71, diameter of acetabulum 0.14, length of testis 0.17, breadth 0.14, diameter of ovary 0.10, longer diameter of ovum 0.069, shorter diameter 0.038, length of pharynx 0.06, distance between pharynx and anterior sucker 0.15.

The excretory vessel was not noted until sections were reached back of the testes, where it becomes a somewhat spacious vessel. The posterior seminal receptacle is situated immediately dorsal to the ovary. In the sectioned specimen the testes were seen to occupy the whole height of the body cavity. In the vicinity of the testes the vitellaria were seen to lie along the lateral margins, on the dorsal side nearly to the median line, and on the ventral not quite so far. Behind the testes they extend entirely around the cavity in which lie the two intestinal crura and the centrally placed excretory vessel.

Distomum sp.

[Plate 39, fig. 71, U. S. N. M. No. 6520.]

Brief mention is here made of a distomum, three examples of which were obtained from the sea robin (*Prionotus carolinus*) August 24. Two specimens of fish were examined. The alimentary canal was opened and washed out in water, with the result given above. My notes, made at the time, characterize these worms as having the head and prominent acetabulum transparent and colorless, the body opaque, white, yellowish behind the acetabulum; neck very short, arcuate; body cylindrical and slightly irregular.

Dimensions, in millimeters, of a specimen in sea water: Length 1.06, length of oral sucker 0.07, breadth of same 0.11, length of acetabulum 0.18, breadth of same 0.21, diameter of neck at narrowest point 0.13, diameter of body 0.26, dorso-ventral diameter of body, including acetabulum, 0.31, same behind acetabulum 0.17, same of neck 0.13, length of neck 0.13. The length of another specimen was 1.78. In a mounted specimen the pharynx measured 0.09 in length and 0.07 in diameter, and the ova 0.048 and 0.031 in the two principal diameters.

Following are the specific characters, so far as I have been able to make them out:

Body unarmed, ecaudate, nearly cylindrical; neck short, cylindrical, varying in position from arcuate to semierect; acetabulum pedicellate about twice the diameter of the oral sucker; mouth terminal; œsophagus none or very short; branches of the intestine simple, extending nearly to the posterior end; testes two, median, juxtaposed, dorsal; ovary immediately in front of the testes, globular, ventral; vitellaria conspicuous, extending from the posterior extremity to the acetabulum; folds of the uterus between the ovary and acetabulum; ova rather large and not very numerous; reproductive aperture immediately in front of the acetabulum.

These specimens possess many characters common to the forms which I have referred doubtfully to *D. simplex* Rudolphi. (Trematode Parasites of Fishes, p. 525).

Distomum sp.

[Plate 39, fig. 72; Plate 40, figs. 73-75.]

Among the numerous small distoma found during the summer of 1898, I note briefly a form found on two occasions, but as only a single specimen was obtained in each case formal identification has not been attempted. Both are characterized by having the body armed with minute, scale-like spines, dense on the neck, but becoming sparse posteriorly on the body. One was obtained from a scup (*Stenotomus chrysops*) August 15, the other from a flounder (*Paralichthys dentatus*) August 25. Since the stomach of the latter contained several small scup, and the distomum was obtained by washing out the alimentary canal of the flounder, the true host of the worm is quite probably the scup.

Dimensions of living specimens, in millimeters:

(1) Specimen from scup: Length 0.62, greatest breadth 0.31, diameter of oral sucker 0.09, of acetabulum 0.09, longer diameter of ova 0.076, shorter diameter of same 0.034.

(2) [U.S.N.M., No. 6521.] Specimen from flounder: Length 1, greatest breadth 0.53, diameter of oral sucker 0.18, of acetabulum 0.18, longer diameters of ova 0.076, shorter diameter of same 0.052. The same specimen mounted in balsam is 1.22 in length and an ovum measured 0.064 and 0.034 in the two principal diameters.

Diagnostic characters, so far as they can be made out from the latter specimen, are as follows: Body ovate, depressed, whitish in life, covered with short scalelike spines becoming sparsely scattered posteriorly; neck short with tendency to be constricted behind oral sucker; mouth subterminal; acetabulum equaling or slightly exceeding mouth; pharynx longer than broad; œsophagus none; branches of intestine, simple, spacious, extending to near posterior end; testes two, median, back of middle of body, close together, relatively large, broader than long; genital aperture in front of acetabulum, a little to the left, cirrus pouch behind acetabulum; ovary subglobular lying immediately in front of anterior testis; uterine folds, containing a few (6) relatively large ova, lying between the ovary and acetabulum; vitellaria along lateral margins from the posterior end to acetabulum.

Immature Distoma encysted in skin of Cunner.

[Plate 40, fig. 76-81, U. S. N. M. No. 6522.]

A cunner (*Tautogolabrus adspersus*) was examined September 5, in which the general surface of the body, including the fins, was covered with minute cysts. The appearance of the fish agreed in minutest detail with Ryder's description of a similar case observed by him (Bulletin U. S. Fish Commission for 1884, pages 37-42). Black pigment cells are very abundant in the vicinity of the cysts, where they make black, opaque masses immediately surrounding the cysts. Pigment is almost entirely absent from the exterior surface of the cyst where the epidermis is tightly stretched. The cysts themselves are nearly transparent. This is true for the larger cysts. The smaller cysts have pigment cells over their surface, but in no greater abundance than normal. As the cysts grow, the pigment cells retreat from the surface and accumulate about the periphery of the cysts as it is seen in optical section when a scale with these cysts is put under a cover glass and examined with aid of a microscope. The red pigment of the skin continues to be represented over surface of cysts longer than the black. In all cysts observed pigment cells were absent from surface just above the young worm.

Ryder thought these cysts were due to the presence of the cercaria of some trematode. He does not appear actually to have seen them. Some of the young removed from the cysts proved to be young distoma, thus confirming the general conclusion of Ryder.

Sections were made of the fins containing numerous cysts, but without throwing any light on the probable identity of the adult species represented by these immature forms. The walls of these cysts, as seen in section, prove to be relatively thick. In one which measured 0.32 by 0.25 mm. in the two principal diameters the wall of the cyst was 0.05 mm. thick.

The following table gives the dimensions, in millimeters, of living specimens removed from cysts:

Measurements.	No. 1.	No. 2.	No. 3.
Length	0.70	0.82	0.47
Maximum breadth	0.17	0.20	0.17
Breadth of anterior sucker	0.06	0.05	0.05
Length of pharynx	0.048	0.04	0.041
Breadth of pharynx	0.035	0.024	0.021
Breadth of acetabulum	......	....	0.045

Diameter of a single cyst, 0.36, not including the surrounding pigment.

Cysts with Trematode Ova.

[Plate 40, figs. 82-84, U. S. N. M. No. 6523.]

Three specimens of white perch (*Morone americana*), examined on August 27, had the viscera generally covered with pigment patches. A study of these not only verified observations of a similar nature published by me in vol. xx, Proceedings of U. S. National Museum, page 537, but confirmed certain conclusions reached with regard to some waxy masses found in a diseased ovary of this fish.

In the specimens ova were found (1) with cyst just beginning; (2) with thick cyst of connective tissue; (3) cyst and ovum both surrounded with a waxy secretion, but ovum still plainly visible; (4) a waxy mass similar in appearance to (3) but with no ovum visible; (5) masses of very dark-brown, almost black, pigment. The ova were not of uniform size; the largest, however, measured 0.020 mm. and 0.013 mm. in the two principal diameters shown in optical section.

Sections of the liver were made, but no pathological features were noted further than presence of ova in pigment patches, of which there were a large number in the serous coat of the liver. 100 ova were estimated in a single section through one of these pigment patches, which would indicate approximately 4,000 ova in the pigment patch.

Gasterostomum ovatum Lt.

[*Monostomum orbiculare* Rudolphi, Linton, Proc. U. S. N. M., vol. XX, pp. 541–542, Pl. LIV, figs. 2-5, U. S. N. M. No. 4872.]

The specimens from *Lobotes surinamensis*, referred by me to the genus Monostomum, belong to the genus Gasterostomum. As they appear to be new, I propose the name *Gasterostomum ovatum* for the species, and give the following emended definition:

Body ovate, depressed, flattened ventrally, convex dorsally. Acetabulum subterminal a little broader than long. Mouth [fig. 3, *ph.*, loc. cit.] at about anterior fourth of body. The mouth is easily overlooked. When a specimen is placed in a transparent medium a subglobular pharynx is seen, in appearance like a small ventral sucker. Vitellaria arranged in a somewhat semicircular band between the mouth and acetabulum along the right side as far as the first testis, and along half the length of the left side. Testes two, subglobular on the right side back of the mouth, and one following the other closely. Ovary globular in front of testes and beside the mouth. Uterus voluminous, crowded with small, nearly globular ova, its folds lying along the left side and midventral line from a point a little in front of the mouth to near the posterior end, where there is a large roundish mass of ova, which in ventral view usually obscures the oblong ovate cirrus pouch. The latter lies near the mid-ventral line, its base on a level with the posterior edge of posterior testis. The external genital aperture is at the posterior end.

Additional measurements, in millimeters: Length 1.91, greatest breadth (at mouth) 0.92; length of acetabulum 0.17, breadth of same 0.2; breadth of mouth 0.07; diameter of oral sucker (pharynx of original description) 0.14; length of anterior testis 0.25, breadth of same 0.21; length of posterior testis 0.21, breadth of same 0.25; diameter of ovary 0.17; diameter of ova (average) about 0.017; distance between acetabulum and mouth (centers) 0.56.

Gasterostomum arcuatum sp. nov.

[Plate 41, figs. 85-90, U. S. N. M. No. 6524.]

On two occasions small trematodes were found in the bonito (*Sarda sarda*)—July 20 numerous, August 8 few—in pyloric cæca and intestine. In the living worm the color of the lateral margins is translucent white, anterior yellowish white, posterior yellowish brown where the ova show through the body wall; neck very changeable, contracting and extending incessantly. These prove to belong to the genus *Gasterostomum*.

The following description is based on preserved specimens: Body slender, cylindrical, tapering gracefully to anterior end, arcuate; posterior end bluntly rounded, covered with minute, low, flat spines, which are dense in front and throughout the greater part of the length of the body; anterior sucker terminal with circular aperture; ventral sucker (mouth) situated little in advance of middle, smaller than anterior sucker, globular; aperture subcircular; intestine short, soon expanding into a

pouch which has a triangular outline, when seen in lateral view, immediately in front of and dorsal to the ovary; testes two, subglobular, the posterior one about midway between the ventral sucker, the anterior midway between the posterior testis and the ventral sucker. The ovary is slightly smaller than the anterior testis and lies in front of it and approximate. The cirrus lies ventrally at the posterior end. It has very thick walls and extends anteriorly to the posterior testis. The vitellaria consist of about 32 conspicuous globular, yellowish-brown masses, which lie for the most part anterior to the ventral sucker. In a specimen which was compressed lightly and viewed from the dorsal side these bodies lay in an irregular double lateral line, 16 on each side. About three of these lateral masses were posterior to the ventral sucker. The remainder extended forward to a point nearly midway between the anterior and the ventral sucker. The folds of the uterus are very voluminous, filling the posterior part of the body and hiding the other organs as far forward as first testis. Ova very numerous, small, size somewhat variable, but average about 0.021 mm. and 0.014 mm. for the two principal diameters.

The following measurements, in millimeters, were obtained from a living specimen: Length, 1.28; diameter anterior sucker, 0.09; diameter at anterior end, 0.01; median diameter, 0.21; diameter at posterior end, 0.14. In a mounted specimen measuring 2.7 mm. in length, the diameter of the anterior sucker was 0.1, the diameter of the ventral sucker was 0.07. In this specimen the ventral sucker was 1.3 mm. from the anterior end, and the length of the cirrus was 0.7 mm. A spacious, thin-walled vessel lies in the anterior part of the body, terminating blindly a short distance back of the anterior sucker, which I take to belong to the excretory system.

Gasterostomum sp.

[Plate 41, fig. 91, U. S. N. M. No. 6525.]

A single specimen from the gar-fish (*Tylosurus marinus*), August 27, is here mentioned. The body is so full of ova that details of the anatomy can not be made out satisfactorily. The body is ovate, tapering uniformly from about the middle to each extremity.

The following dimensions are given in millimeters:

(1) In sea water: Length 0.85; diameter, anterior, 0.14; greatest diameter, near middle, 0.43; diameter, posterior, 0.17.

(2) Specimen mounted in balsam, length, 0.92; greatest diameter, 0.5; length of acetabulum, side view, 0.25; length of aperture of same, 0.1; diameter of oral, i. e., ventral sucker, 0.076; depth of same, 0.104; longer diameter of ova, 0.017; shorter diameter of ova, 0.01.

The vitellaria, seen from the side, form a cluster of subglobular bodies placed dorsally on a level with the space between the acetabulum and mouth. The cirrus and cirrus-pouch are median in position, extending from near the middle of the body to the posterior end. Testes and ovary could not be seen distinctly on account of the voluminous uterus crowded with ova; so far as could be made out, they appear to lie on the right side, having about the same position as in *G. ovatum*.

Calyptrobothrium occidentale sp. nov.

[Plate 41, figs. 92–97, U. S. N. M. No. 6526.]

One large and six small cestodes from the intestine of the torpedo (*Tetranarce occidentalis*) July 25, and two small specimens from the same host on July 26, are here included.

The genus *Calyptrobothrium* was erected by Monticelli (*C. riggii*, Naturalista Siciliano, An. XII, 1893, p. 15, pl. I, figs. 1–4) to accommodate a species found in *Torpedo marmorata*.

At the time of collecting I thought that the small specimens on the one hand and the large specimen on the other belonged to distinct species. After a careful comparison, however, I am led to the belief that they belong to the same species.

Synopsis of species: Head truncate, bothria four, in lateral pairs. Anterior end of bothria with horseshoe-shaped sucker, posterior end auriculate; bothria prominent and retractile, or partly so, in small specimens, nearly sessile in large specimens on account of thickening of axial part of head; posterior part of head continuing into a subcylindrical neck, which is about as long as the head proper in the large specimen, but over three times as long in the small specimens. First segments remote from the head very short; strobile linear; posterior segments rectilinear (ripe segments not seen); reproductive cloacæ on lateral margins about middle of length of segments.

The following dimensions in millimeters were taken from alcoholic specimen: Diameter of head, lateral 1.95, marginal, 1.76; length of bothrial portion 1.8; distance from anterior end to where neck begins to diminish 4; thickness of neck just back of bothria 1.4; distance to first distinct segments 150; breadth of first distinct segments 0.84; length of last segments 0.56, breadth 0.9, thickness 0.37; length of head and neck 6. Length of large specimen in life, 250 mm. Small specimens not measured in life. The longest preserved small specimens are 18 mm. in length. A few measurements were made of the head of one in life, as follows: Breadth, bothria being extended nearly at right angles to axis 1.33; length of head proper, about 0.37; distance from anterior end to base of neck 1.33; diameter of neck just behind the bothria 0.46, diameter just before it begins to abruptly diminish 0.36; breadth just back of neck 0.24; length of posterior segments 0.32, breadth 0.65.

In the small specimens the first indication of segments, which appear as faint transverse annulations, is about 8 mm. back of the head. The last segments are immature. In general proportions and shape they resemble the segments of the large specimen.

The principal difference between the large specimen and the small ones is in the appearance of the head rather than in any essential dissimilarity of the bothria. In both the bothria are in pairs, and the pairs are on the sides of the head which correspond with the margins of the body. In the alcoholic specimens the bothria are seen to be arranged in pairs, but the auriculate parts are directed in opposite directions, so that the two auriculate portions which are seen on the same side of the head really belong to different pairs of bothria (fig. 93).

In large and small specimens alike the anterior part of a bothrium consists of a strong muscular sucker, shaped like a horseshoe, with the break in its border turned toward the posterior tip of the bothrium. The latter in the small specimens stands out as an auriculate appendage nearly at right angles to the axis of the body, while in the large specimens they are appressed. The neck in each case is thicker than the anterior part of the body, being, in fact, nearly cylindrical for a short distance back of the head, where it diminishes in thickness, and, in the large specimen, also in breadth, rather abruptly. This cylindrical neck in the large specimen, proportionally to the head and body, is much larger than in the small specimens. The enlargement appears to affect the axial part of head also, thus filling in the interbothrial spaces and making the bothria sessile instead of prominent, as in the smaller ones.

The genus *Monorygma* is suggested by this species, and indeed Monticelli places the genus *Calyptrobothrium* near that genus. The head terminates abruptly without an eminence of any kind, which excludes the genus *Monorygma*. Again, the muscular auxiliary sucker on the front end of the bothria is of altogether different character from the auxiliary acetabulum of *Phyllobothrium*.

Sections were made of several of the posterior segments of the large specimen, and, while the segments are immature, the general arrangement of the reproductive organs could be made out. The cirrus-pouch is pyriform and lies near one of the lateral margins, where it opens near middle of the length of proglottis. Within the bulb lie several convolutions of the vas deferens. The retracted cirrus was minute and not fully developed. A granular appearance on its walls suggested what might later develop into spines. The globular testicules occupy central portion of proglottis, mainly from a little behind the middle to anterior border. The vagina opens in front of the cirrus in a common genital cloaca. The vitelline glands are voluminous and lie along the lateral margins. The ovary was identified as a smallish, lobulated mass of nuclei lying near the posterior margin of the proglottis, and staining somewhat differently from the vitelline glands. All the organs were for the most part masses of nuclei, staining deeply in carmine and presenting few differences. In the center of the segments was a mass of nuclei, some of which appeared to be traveling to the vitellaria, and others forming the vas deferens and uterus. The latter, or what was so interpreted, appeared as a relatively large open space surrounded by a clustering mass of nuclei.

Sections of posterior segments from the small specimens show testicules already begun and the rudiment of a cirrus-pouch.

The neck, when sectioned, is seen to enlarge from the anterior part of the body by the expansion of the inner parenchyma, which consists of loosely intersecting fibers with wide meshes, through which the longitudinal vessels pass in strong spirals. In the peripheral portions the longitudinal muscle fibers are very strongly developed. Nuclei are sparse in the central portion of the neck except in the vicinity of the spiral longitudinal vessels.

The most obvious difference between this species and Monticelli's species is in the character of the neck; in *C. riggii* the neck merges imperceptibly into the body, while in *C. occidentale* the neck is much thicker than the body and narrows rather abruptly a short distance back of the head.

Platybothrium sp.

[Plate 42, figs. 98, 99, U. S. N. M. No. 6527.]

On August 18, a single specimen of the genus *Platybothrium* was obtained from the spiral valve of the hammer-head shark (*Sphyrna zygæna*). As the genus with the previously-described species (*P. cervinum*) rests on a single specimen from the dusky shark (*Carcharinus obscurus*), I shall not venture to bestow a specific name on this specimen until more material is available.

The head agrees with *P. cervinum*, particularly in the character of the hooks. There are, however, two costæ on the posterior end of each bothrium, a character not clearly made out in *P. cervinum*. The greatest difference is in the size; whereas the length of the specimen upon which the species *P. cervinum* was founded was 67 mm., that of the specimen under consideration is only 3.55 mm. The neck in this specimen is densely beset with conical spines, which is not a character of the other. It is possible that this may be a character peculiar to young strobiles. The difference in hosts can hardly be considered as weighing against probable identity of species, as this specimen was associated with several representatives of *Phoreiobothrium lasium*, also first described from the dusky shark.

Head as in *P. cervinum*, broad, flat, and thin; bothria four, each armed with a pair of two-pronged antler-like hooks, connected with each other at the base by a short chitinous bar; bothria truncate in front, with two short costæ behind. Neck spinose, slender, and of nearly uniform size for about 0.7 mm., then enlarging abruptly, thickened and somewhat fleshy, probably a contraction condition. Segments at first much broader than long, but increasing in length gradually; last segment longer than broad, with rounded ends, not mature, but appeared to be loosely attached.

Dimensions of living specimen in millimeters: Length 3.55, length of head 0.31, breadth of head 0.35, diameter of neck 0.06, distance to first segment 0.48, length of first segment 0.1, breadth of first segment 0.28, length of last segment 0.5, breadth of last segment 0.33, length of spines on neck 0.035, number of segments 6.

The spines are abundant on the neck, becoming sparse on the first segments and occurring only scatteringly on the lateral margins of other segments.

Larval Cestode from the Bonito.

[Plate 42, fig. 100, U. S. N. M. No. 6528.]

Among the few entozoa found in the bonito (*Sarda sarda*) is a small blastocyst which was liberated from a cyst on the pyloric cæca. The length of the living specimen was 3 to 6 mm., depending on the state of contraction. When set free from the cyst it was very active, contracting and expanding and even making some headway in progression in a forward direction. There was a small aperture at each end, and along the central region were numerous roundish bodies. There is a well-marked constriction just back of the head in the alcoholic specimen, 0.13 mm. from the tip, whence it tapers to a blunt point. The mouth communicates with a short canal.

The following dimensions, in millimeters, are of the specimen mounted in balsam: Length about 4, breadth at anterior constriction 0.31, slightly broader than this a short way back of constriction, then narrowing to 0.18 at middle, expanding again to 0.34 near the posterior end.

Beginning just back of the constriction and continuing for about three-fourths of the length there are suspended in the middle of the body an elongated cluster of pyriform structures, each about 0.035 in the longer and 0.028 in the shorter diameter. Each is attached by a slender stalk at the smaller end. I have recorded something similar to this in a larval Rhynchobothrium from the intestine of the sand shark (*Carcharias littoralis*). [Proceedings of the U. S. National Museum, vol. XIX, p. 797, pl. LXIII, figs. 14–16.] The walls of the body were very thickly set with nuclei.

The specimen was embedded and cut into longitudinal sections in the attempt to ascertain the nature of these pyriform bodies. Like the parenchyma generally they were scarcely at all stained by carmine. By transmitted light they appeared to be of a faint yellowish-brown color. No structure could be made out in these central bodies. While many of them are pyriform, this designation does not fit all of them. In sections the body wall is seen to be very thin.

On the Occurrence of Cysts in the Stomach Wall of Pomatomus saltatrix.

[Plate 42, fig. 101, U. S. N. M. No. 6529.]

A piece of the stomach wall, about 8 mm. square, comprising the mucosa and submucosa taken from the stomach of a blue-fish July 23, was stained in borax carmine and sectioned.

One of these sections, measuring 8 mm. in length, had passed through six distinct cysts, each containing, so far as it was possible to determine, a larval *Tetrarhynchus*. Some of the cysts contained embryos which were too young for certain identification. The combined length of these cysts was 3.5 mm. The superficial area included in the sections of these cysts represented two-fifths of the area of the submucosa of the entire section. If this ratio of cysts and submucosa were maintained throughout the stomach of the fish it would follow that something like 12 per cent of the tissue of the stomach consists of foreign tissue if not actively inimical to life at least passively so. The amount of energy consumed in building up the protective cysts about these embryos, and of digested and absorbed food which is diverted to the use of these vagrants, must be considerable. The above is possibly somewhat above the average, although it may be below it, for it is a common thing to find the submucosa of the stomachs of blue-fish, squeteague, flounders, etc., so full of cysts that the space occupied by the cysts, as seen on superficial view, appears to be quite as much as the space remaining between the cysts.

The outside wall of each cyst consists of connective tissue fibers in concentric circles, compact but merging in places into the connective tissue elements, with numerous nuclei. Within this is the cyst proper, the outer layer of which stains deeply in carmine and is made up of a few concentric, plate-like, structureless layers, which are somewhat brittle. Within this is the blastocyst. The outer layer of blastocyst and the closely underlying muscular elements stain moderately, but the inclosed parenchyma, which makes up the interior, stains very little. The embryo, on the other hand, stains quickly and strongly in carmine. The parenchyma in these sections is an opened meshwork of unstained tissue, with sparse nuclei scattered through it. Near the boundary the nuclei become abundant.

The above-mentioned membranes were measured in one cyst with the following result, dimensions in millimeters: Thickness of outer nucleated connective layer 0.02, of inner non-nucleated layer 0.007, of outer layer of blastocyst 0.007.

Cysts from Kidneys of Scup.

[U. S. N. M. No. 6530.]

Small globular cysts were found in the kidneys of a scup (*Stenotomus chrysops*) August 4. These cysts were about 1.5 mm. in diameter. Two of them were opened, but nothing could be made out of the contents. There were also small blotches of black pigment on the surface of the kidneys.

A few of these cysts were sectioned, with the following result: The cysts appear to be small tumors, 1 mm. or less in diameter. They are composed entirely of connective tissue and are exceedingly compact. Toward the periphery of the tumor there is a concentric arrangement of the fibers which is quite distinct, portions showing a tendency to separate, or rather to become slightly loosened from the general mass. Though this concentric arrangement was traceable from the greater part of the periphery well toward the center, it was lost near the center, and at one side was indistinct. Nuclei were abundant throughout the mass. Only the tumors, with what tissues remained adherent to them on removal from kidneys, were preserved; but the sections disclose an abnormal condition of the adjacent tissues in that they are infiltrated with blood so as to resemble a blood clot with a few uriniferous tubules penetrating it. In this infiltrated tissue lie also numerous small black pigment masses.

Such conditions call for further investigation to bring out the actual structure and the extent to which the tissues are affected. No nucleus could be distinguished in any of the tumors sectioned.

On Cysts in Stomach-wall of the Black Sea-bass (Centropristes striatus).

[Plate 42, figs. 103, 104, U. S. N. M. No. 6531.]

A number of sections were made and mounted serially of a part of the stomach-wall of a black sea-bass, collected July 28. A study of these sections reveals the fact that some of these cysts are formed around blastocysts which contain larvæ. In a few cases they were developed far enough to show by the character of the hooks that they were near if not identical with forms already described from this host. (Notes on Larval Cestode Parasites of Fishes, pp. 793–794, pl. II, fig. 12.) Others are too young to admit of identification further than that they represent the early stage of some cestode worm, but presumably most if not all of them belong to the genus *Rhynchobothrium*, and possibly to a single species.

Fig. 103 is the sketch of a section through one of these small cysts; the longer diameter of the blastocyst is 0.19 mm., the shorter 0.15. The blastocyst is surrounded by a fine granular coat, 0.007 mm. thick, with a few refractile bodies. This coat in turn is closely invested with a thin covering of connective tissue 0.003 mm. thick. Concentric layers of connective tissue arranged somewhat loosely lie outside of this and are very abundantly supplied with nuclei. The latter layer is about 0.038 mm. thick where the layers are most crowded, and 0.055 mm. where more open. Outside the concentric nucleated area the connective tissue is normal, with few nuclei. These cysts lie in the submucosa.

Ascaris clavata Rudolphi.

[Plate 43, figs. 105-108, U. S. N. M. No. 6532.]

About 50 specimens were collected July 14 from the stomach of a pollock (*Pollachius virens*) by Prof. H. M. Kelly. I have obtained this species frequently in former years from the cod and twice from the pollock, although my notes on the species have never been published. Diesing's synopsis of the species is:

"Head with two linear posteriorly decurrent alæ; mouth with large rounded lips. Body anteriorly very much attenuated, moderately inflected; caudal extremity of the male inflected with mucronate tip; copulatory spines arcuate."

The following characters adapted from von Linstow's description are added, being in close agreement with what I observe in these specimens: Head and tail ends inflected. Upper lip extended, the pulp cylindrical, somewhat narrowed in the middle, two roundish projections on the inner side. The anterior border and the base of the upper lip are of equal size and equal to half of the greatest breadth. The two papillæ are small and situated far toward the front. The œsophagus measures one-fourteenth of the body length. The intestine continues in front, where it springs from the œsophagus into a cæcum 1.8 mm. in length and lying beside the œsophagus, while the latter likewise continues posteriorly in a cæcum which lies beside the intestine and is of equal length with the first cæcum, but only half as broad. The male is 45 mm. long (see below) and 1 mm. broad, the tail measuring $\frac{1}{285}$ of the body length; the tail end is sharpened to a point, its extreme end being beset with little brilliant elevations; the cirri measure 2.2 mm. and are thus relatively long. There appear to be 27 preanal and 6 postanal papillæ. The female has a length of 70 and a breadth of 1.3 mm.; the tail is bluntly conical, with somewhat diminished tip; it equals $\frac{1}{147}$ of the body length.

The foregoing description agrees well with the individuals under consideration, except that I find the length of my specimens falls short of the dimensions given by von Linstow. The largest females measured 60 and the largest males 40 mm. in length.

In one specimen, a male, examined with some care, the œsophagus was about one-tenth of the body length. The cephalad prolongation of the intestine at its juncture with the œsophagus was seen distinctly; the caudad prolongation of the œsophagus was also made out, but less clearly. The character of the cirri is exactly that given by von Linstow. The upper lip presents some differences from the above description, the pulp being somewhat clavate in shape and relatively broader near the anterior end than indicated in von Linstow's figure and description. The lip is also relatively shorter and broader. The papillæ were not studied very closely in this lot, but so far as they could be determined in a specimen seen in lateral view, they agreed in number and position with published descriptions of the species.

Ascaris habena sp. nov.

[Plate 43, figs. 109-115, U. S. N. M. No. 6533.]

On September 5, eight nematodes were obtained from stomach and intestines of two specimens of toad-fish (*Opsanus tau*). I have seen this species often in previous years at Woods Hole, in this host.

Body tapering gracefully from near the posterior to the anterior end; jaws prominent, each with lateral membranes and two papillæ, rhomboidal but rounded anteriorly, pulp expanding toward tip and becoming broadly club-shaped and two-lobed, each armed with four horny teeth. Tail somewhat variable in preserved specimens, short conical or even truncate, sometimes mucronate at tip, that of males shorter than females. Minute lateral wings are present at anterior end, though they were not noticed until transverse sections were made. The cuticle generally is smooth, but transverse striæ, 0.01 mm. apart, were noticed near the posterior end in one case. The posterior end exhibits a strong tendency to curve ventrally in the females as well as in the males. In fact, more success was had in straightening the males than the females in the killing fluid. The greatest diameter, especially in the case of the females, is near the posterior end.

In a female measuring 36 mm. in length the œsophagus was 6 mm. in length.

The anal papillæ in a male were made out to have the following arrangement: There are 28 papillæ on each side, 24 preanal and 4 postanal. The postanal papillæ are very small. The posterior 4 preanal papillæ are also very small. These are preceded by 4 of medium size, and these again by 16 large, prominent papillæ. While the number appears to be the same on the two sides, those on right side extend a little farther forward than those on left. The spicules not made out clearly.

Dimensions in millimeters of alcoholic specimen in acetic acid, side view:

(1) Of a male; length 29, length of head 0.14, diameter of head 0.14, diameter 5 mm. back of head 0.26, diameter at middle of body length 0.66, diameter 5 mm. from posterior end 0.77, diameter at anal aperture 0.14, length of tail 0.07.

(2) Of a female; length 42, length of head 0.22, diameter of head 0.22, diameter 5 mm. back of head 0.46, diameter at middle of body length 0.95, diameter 5 mm. from the posterior end 1.5; diameter at anal aperture 0.33, length of tail, 0.35.

Acanthocheilus nidifex sp. nov.

[Plate 43, figs. 116–119, U. S. N. M. 6534.]

On August 11 and 19, large nematodes, with minute, inconspicuous jaws, were found in the stomach-wall of the tiger shark (*Galeocerdo tigrinus*), which appear to belong to an undescribed species. The body tapers from a short distance in front of the middle to the anterior end, while it is of nearly uniform size from the middle to near the posterior end, plump and smooth, the cuticle crossed by faint transverse striæ. Head minute, three-lobed. Since in some cases three small lobes could be seen distinctly, while in others the three-lobed character of the mouth is not so plainly shown, it would appear that the worm has the power of retracting these oral lobes. Two minute conical papillæ, with their points directed forward, could be made out on one of the lobes of a small specimen. A large specimen, when viewed from the ventral side in acetic acid, showed two papillæ plainly on each of the lateral lobes. The aperture of the mouth is very minute and is turned a little toward the ventral side. The tail is rather slender conical, and about equals in length the diameter of body at anal aperture. Lips of anal aperture in large females rather prominently rounded.

The anal papillæ were not made out with entire satisfaction. A specimen was prepared in the following way: After staining, the dorsal portion of the posterior end was cut away and the ventral portion spread out on a slide, ventral side uppermost, and mounted in balsam. In some way the postanal part was lost, so that only the preanal papillæ are shown. These are arranged in a double row on each side of the median line. On the left side the arrangement is regular, and eight pairs, or sixteen single papillæ, were counted. On the right side, while about the same number of papillæ were counted, they were not arranged so regularly as on the left side. They were, however, in two rows, as on the left side. The walls of the intestine are much folded, especially toward the posterior end. A branch of the intestine extends forward from the base of the œsophagus and lies beside that organ. The thickness of the cuticle is about 0.05 mm. The ova, with which the uterus of the specimen sectioned was crowded, were 0.04 mm. in diameter, with a transparent, non-staining envelope, surrounding a granular mass which stains strongly in alum carmine; the diameter of this mass is about 0.028 mm.

Dimensions of a large female (alcoholic) in millimeters: Length 125, diameter of head 0.21, greatest diameter of body 2.5, diameter at anus 0.78, length of tail, 0.78. In another of the same length the diameter in front of the anus was 0.57 and the length of the tail 0.64. In a small specimen, also a female, 35 mm. in length, the length of the œsophagus was 4 mm.

These worms occur in crypts or nests, for the most part in the submucosa of the stomach. In the lot collected August 11 they were first noticed as hard cyst-like places in the stomach wall. When these were cut into the worms were liberated. There appeared to be a male and female, at least a large and a small worm, together in most cases. Two of the crypts were lined with a continuation of the stomach epithelium, which had apparently closed over the point of entrance from the interior of the stomach. In one case the worms lay between the two muscular coats of the stomach wall. One small specimen was free in the stomach, and one large one was found along with the viscera, but since the head of the shark had been cut off before I examined it for entozoa, these nematodes may have been liberated by the decapitation, the plane of which passed through the anterior end of the stomach. The specimens were not inclosed in cysts of connective tissue.

In the shark examined on August 19 my attention was attracted to these worms by noticing in the mucous membrane of the stomach, which had been carefully washed, that there were a few nema-

todes protruding their heads two or three centimeters from the mucous membrane, into which they would rapidly withdraw when touched. It was then noticed that they were in the vicinity of swollen masses, apparently cysts in the stomach wall. An examination of one of these revealed a large nematode coiled up in this living nest, not encysted, but able to leave the nest whenever occasion demanded. The mucous membrane was dissected away from one of these worms, showing that it was coiled up in the submucosa (fig. 116). Around it, for a space some 3 cm. square, the tissues were highly inflamed and filled with extravasated blood. Pus was also observed in at least one of these cavities, occupied by a nematode.

Although the worms are not completely encysted there is evidently a considerable accumulation of connective tissues in the submucosa in the vicinity of these nests. Communication seems to be maintained by the worm between the crypt and the lumen of the stomach.

This habit of making a nest for itself in the stomach wall of its host is certainly an unusual one, and for the comfort of a groaning and travailing creation it is to be hoped that there are few parallel cases in nature.

Ichthyonema sanguineum Rudolphi (?).

[Plate 43, figs. 120-121, U. S. N. M. No. 6535.]

A single example of a blood-red nematode from the inside of the cheek of a flounder (*Paralichthys dentatus*), where it was partly embedded, appears to be near to or identical with *Ichthyonema sanguineum*. The flesh of the host was much inflamed in the vicinity of the worm. The specimen proved to be a female and was crowded with young. The latter are very minute, one end blunt, the other exceedingly attenuate. I have not examined the young of this genus with great care, although I have collected them at different times. In my notes I find that I have been calling the attenuate end the anterior, but since this is contrary to authorities on this subject I have probably been in error. My notes made at the time of collecting would appear to state that the progressive motion of these worms is in the direction of the smaller end.

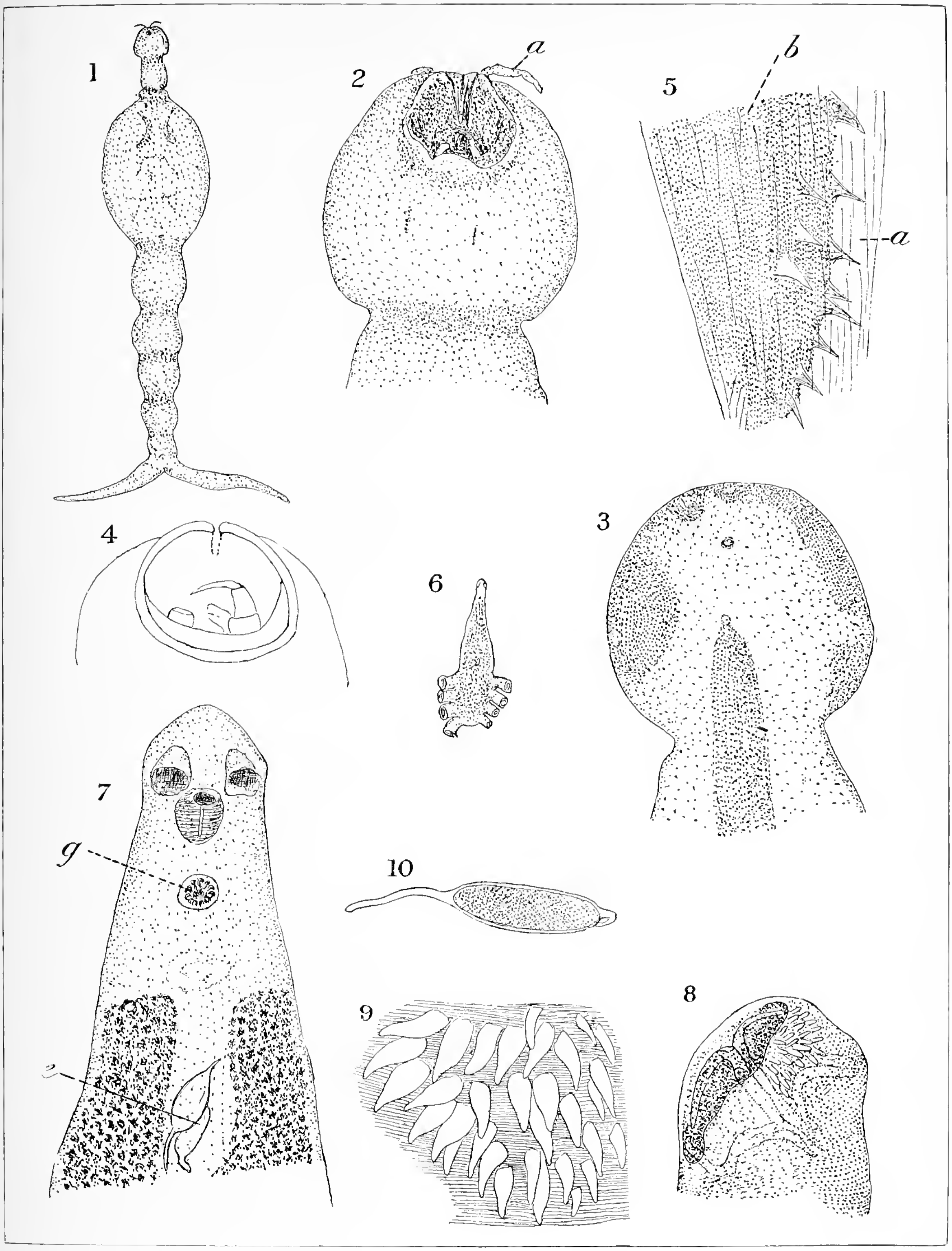
The body of the adult is linear and narrows rather abruptly at the anterior end. The head bears four broad lobes or flat surfaces, each of which carries two papillæ. The œsophagus, at first slender, enlarges gradually to a point a little behind the middle of its length, whence it maintains about the same diameter to its rounded base. The intestine at its beginning is but little larger in diameter than the œsophagus. A slender anterior portion of the ovary is seen lying beside and across the œsophagus. The uterus is very spacious. The sections of the anterior end which were made show considerable variation in the relative dimensions of uterus and intestine. In most of the sections the uterus occupies far the greater part of the body cavity, and is filled with the young, of which there is an immense number. Near the posterior end the diameter increases and the posterior end is bluntly rounded.

The following dimensions, in millimeters, are of the preserved specimen: Length 30; diameter of head 0.23; length of œsophagus 1.14; diameter of œsophagus, anterior 0.1, posterior 0.17; greatest diameter (specimen somewhat flattened) 1; diameter near posterior end 0.85.

EXPLANATION OF PLATES.

a. Acetabulum.
c. Cirrus.
e. Ova.
cp. Cirrus pouch.
ex. Excretory vessel.
g. Genital aperture.
i. Intestine.
o. Ovary.
p. Prostate gland.
ph. Pharynx.
sr. Seminal receptacle.
sv. Seminal vesicle.
t. Testis.
u. Uterus.
vd. Vas deferens.
vg. Vitelline gland.
yd. Vitelline duct.

The figures have been reduced about one-fifth.

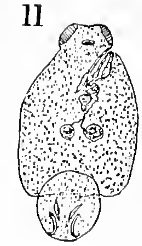


Parasitic copepod from Cynoscion regalis.

1. Dorsal view of specimen showing the minute antennæ and the single eye, from life. × 8.
2. Ventral view of head, from life. × 68.
3. Dorsal view of head, from life. × 68.
4. Ventral view, from glycerin mount. × 100.
The right maxilla is broken, its basal joint alone remaining.
5. Portion of one of the tail forks. × 100.
a, Chitinous cuticle; *b*, subcuticular tissue joined with the cuticle by spine-like processes.

Octobothrium denticulatum from Pollachius virens, gills.

6. Ventral view, alcoholic specimen. × 4.
7. Ventral view of anterior end. × 68.
e, Ova; *g*, cirrus with its circle of bifurcate hooks.
8. One of the posterior suckers showing chitinous hooks and patch of papillæ. × 68.
9. Papillæ more highly magnified. × 260.
10. Ovum, sketched as it lay in the uterus; one of the filaments concealed in part. × 176.

11


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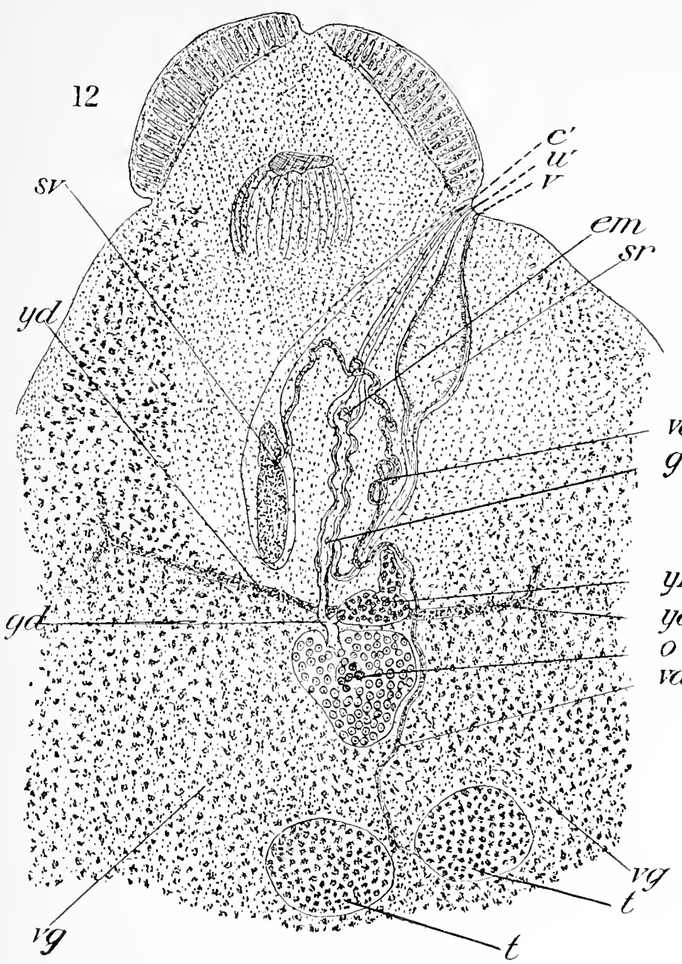

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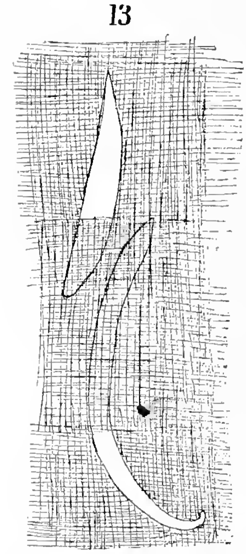

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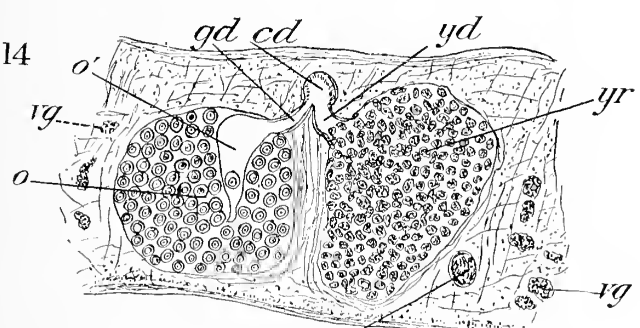

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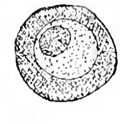


Epibdella bumpusii sp. nov. from the exterior of Dasyatis centrura.

11. Ventral view of specimen mounted in balsam. × 4.
12. Ventral view of anterior half of same showing the arrangement of the genital organs, partly diagrammatic. × 38.

c', Aperture of cirrus; *em*, portion of uterus where the eggs are molded and the shell laid on; *gd*, germ duct at the point where it is joined by the short yolk duct (see *yd*, fig. 14); *gd'*, germ duct at the point where it is joined by the seminal duct; *sr*, seminal receptacle; *u'*, opening of uterus; *v*, opening of vagina; *yr*, vitelline reservoir.

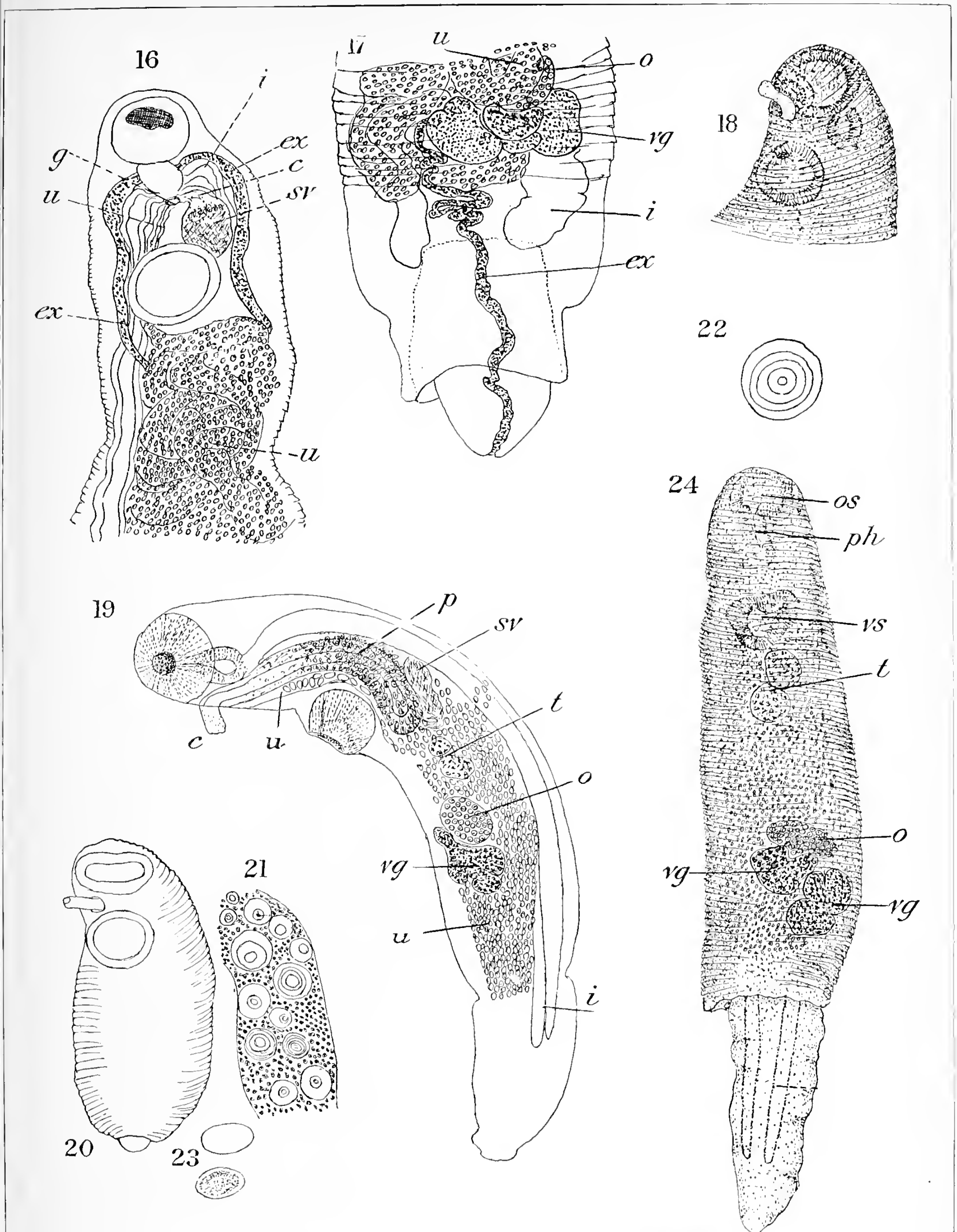
The line from *o* indicates a part of the ovary in which the germ cells were free to move and were always thrown into a state of oscillation by the rush of yolk from the reservoir (*yr*) which preceded the formation of each egg.

The line *sv* touches the seminal vesicle at a point where a regular pulsation was observed, which still continued in a specimen which had been lying in sea water for twelve hours, most of the time under a cover glass.

13. A pair of hooks from the posterior sucker. × 68.
14. Transverse section through the ovary and yolk reservoir. × 100.

cd, Germ duct at the point where it is joined by the short duct from the yolk reservoir (*yr*); *gd*, germ duct; *o'*, beginning of the germ duct in the ovary in which oscillating germs were observed in the living specimen.

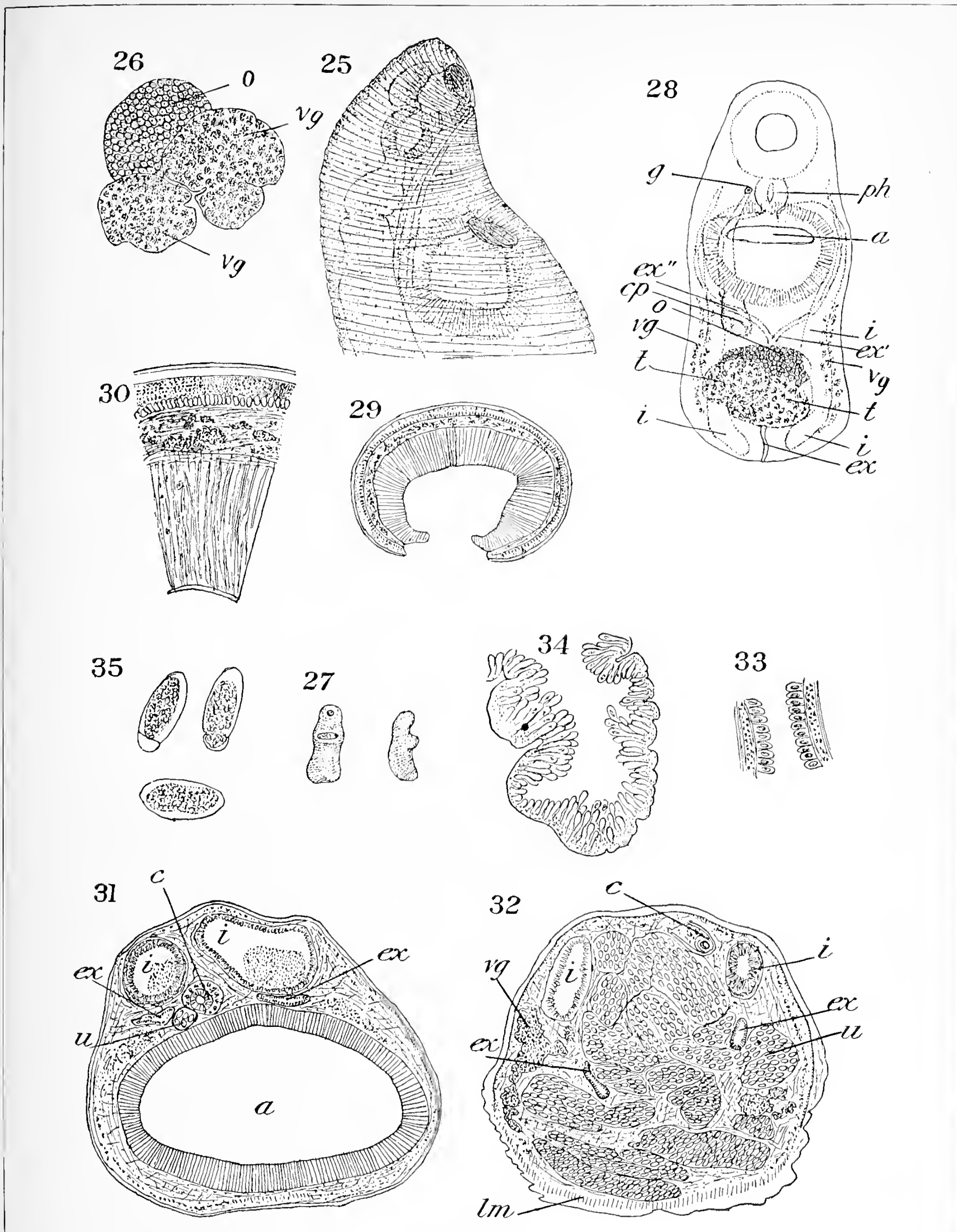
15. Germ cell. × 800.



Distomum ocreatum from Pollachius virens and Merluccius bilinearis.

16. Anterior end, ventral view, from life, somewhat compressed. × 68.
17. Posterior end of same specimen, ventral view, from life, somewhat compressed. × 68.
18. Smaller specimen, from life, anterior view. × 100.
19. Small specimen in glycerin, side view.
20. Small specimen, from life, ventral view. × 100.
21. Portion of excretory vessel with concretionary masses, from life. × 440.
22. Single concretion. × 750.
23. Ova. × 440.
24. Alcoholic specimen, dorsal view. × 100.

Nos. 16 to 23 from *Merluccius bilinearis*.
No. 24 from *Pollachius virens*.

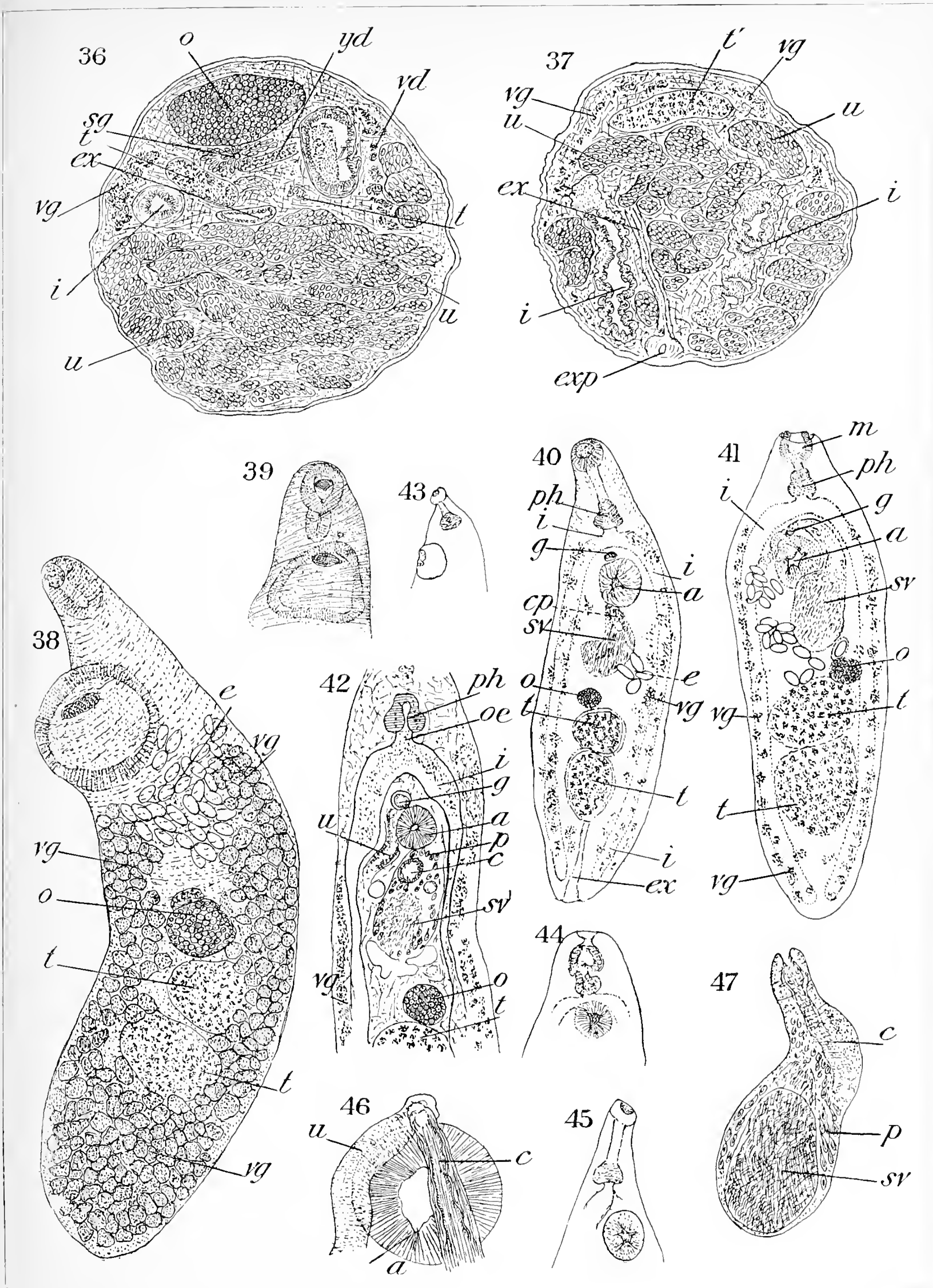


Distomum appendiculatum from Paraliehthys dentatus.

25. Anterior end, lateral view. × 300.
26. Ovary and vitelline glands of same. × 300.

Distomum fœcundum sp. nov. from Lopholatilus chamæleonticeps.

27. Lateral and ventral views, alcoholic specimen. × 5.
28. Diagrammatic ventral view, restored from sections. × 25. The voluminous uterine folds have been omitted. *ex'*, Left, and *ex''*, right excretory vessel. *a*, Aperture of acetabulum.
29. Transverse section through oral sucker. × 70.
30. Details of same. × 250.
31. Transverse section through acetabulum, about the middle of the latter. The branches of the intestine contain granular fæcal matter.
32. Transverse section between acetabulum and ovary. × 76. *lm*, Longitudinal muscles.
33. Walls of excretory vessel near posterior end. × 250. (See fig. 37.)
34. Walls of intestine at posterior end. × 250. (See fig. 37.)
35. Ova. × 450.



Distomum fœcundum from Lopholatilus chamæleonticeps—Continued.

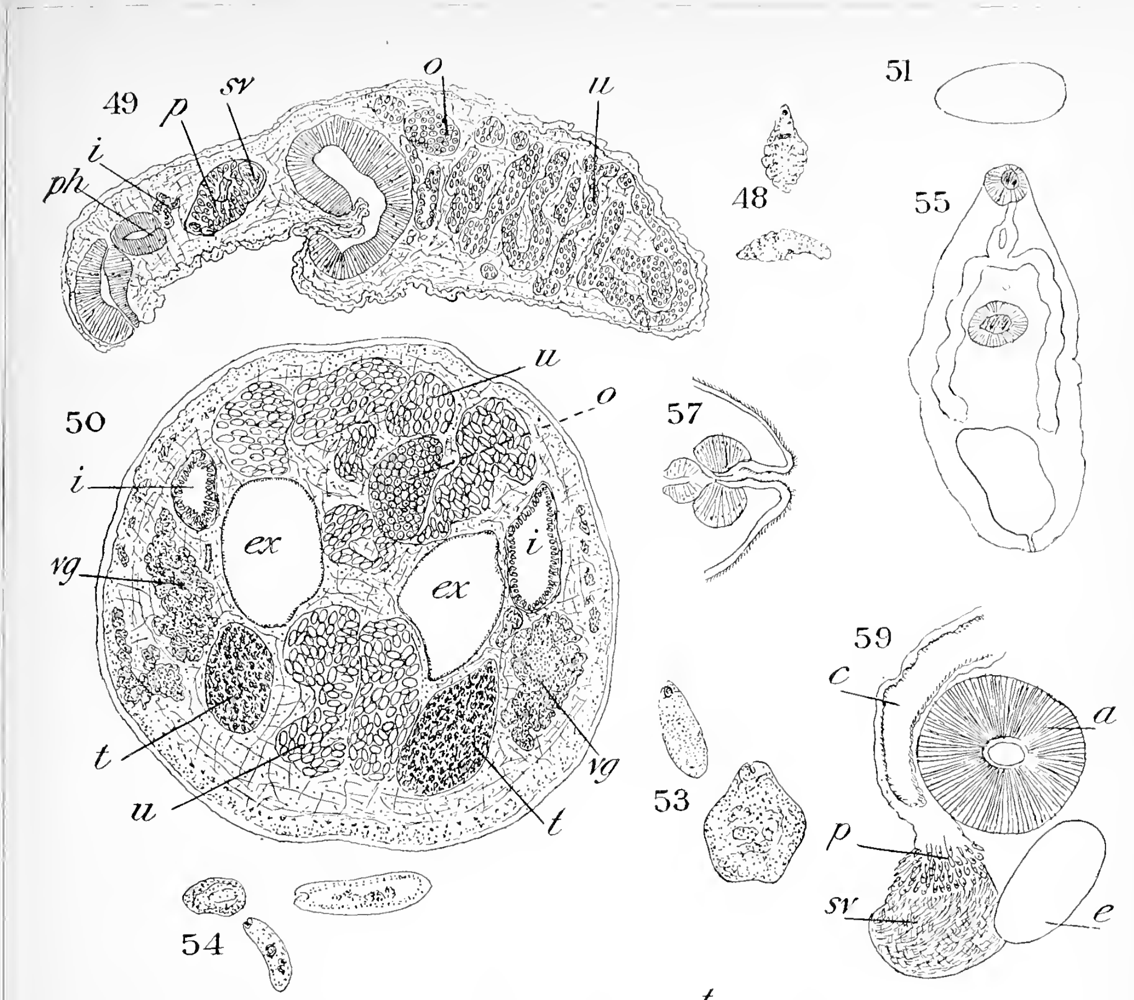
36. Transverse section through ovary and testes. × 70.
    sg, Shell gland; *t*, right testis; *t'*, beginning of left testis.
37. Section behind ovary. × 70.
    exp, Terminal excretory pore; *t'*, left testis.
    Note that the body of the worm was flexed ventrally, so that what were transverse sections for the greater part of the length became nearly horizontal at the posterior end.

Distomum vitellosum sp. nov. from Merluccius bilinearis.

38. Ventro-lateral view, from life. × 100.
39. Ventral view of anterior end, balsam mount. × 100.

Distomum pudens sp. nov. from Paralichthys dentatus.

40. Longitudinal horizontal section of a specimen measuring 1.25 mm. in length.
41. Longitudinal horizontal section of a specimen measuring 1.65 mm. in length.
    m, Anterior sucker retracted.
42. Middle part of longitudinal horizontal section of another specimen. × 70. *oe*, Œsophagus.
43. Side view of anterior end. × 70.
44. Ventral view anterior sucker retracted. × 70.
45. Ventro-lateral view of a specimen with conical neck. × 70.
46. Acetabulum, uterus, and cirrus, dorsal view. × 260.
47. Cirrus, cirrus-pouch, prostate and seminal vescicle, as shown in a longitudinal horizontal section. × 160.

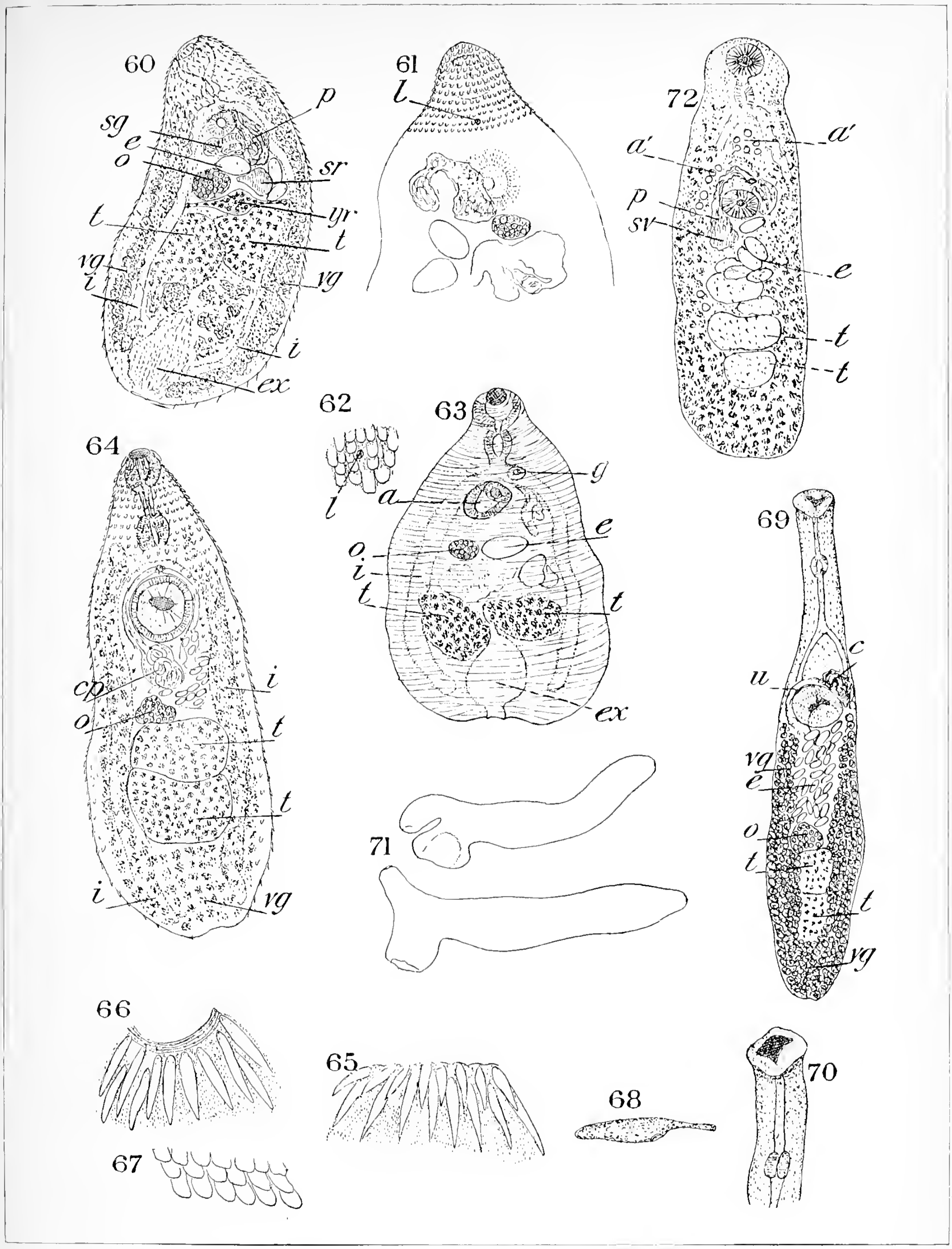


Distomum vibex sp. nov. from Spheroides maculatus.

48. Ventral and lateral views of an alcoholic specimen. × 4.
49. Median longitudinal vertical section. × 24.
50. Transverse section through ovary and testes. × 54.
51. Ovum. × 300.

Distomum pyriforme sp. nov. from Palinurichthys perciformis.

52. Portion of section of pyloric cæca with distoma. × 80.
53, 54. Specimens showing some different forms, alcoholic. × 50.
55. Specimen with large caudal excretory vessel, life. × 176.
56. Dorsal view, life. × 176.
 sr, Seminal receptacle (?); *a′*, spherical bodies with concentric structure.
57. Longitudinal horizontal section of anterior end, showing invaginated oral sucker. × 330.
58. Median longitudinal vertical section. × 250.
59. Acetabulum, cirrus, prostate, seminal vesicle, and ovum. × 440.



Distomum areolatum (?) from Morone americana.

60. Ventral view. × 70.
61. Dorsal view of anterior portion, life; spines not shown except in front. × 176.
    l, Opening of Laurer's canal.
62. Spines and opening of Laurer's canal, life. × 440.
63. Ventral view, life; spines not shown. × 100.

Distomum dentatum sp. nov. from Paralichthys dentatus.

64. Ventral view, life; sketch made after the specimen had been lying under the cover glass for some time. × 100.
65. Dorsal view of oral spines. × 400.
66. Ventral view of oral spines. × 400.
67. Flat scale-like spines of body. × 440.

Distomum fragile sp. nov. from Mola mola.

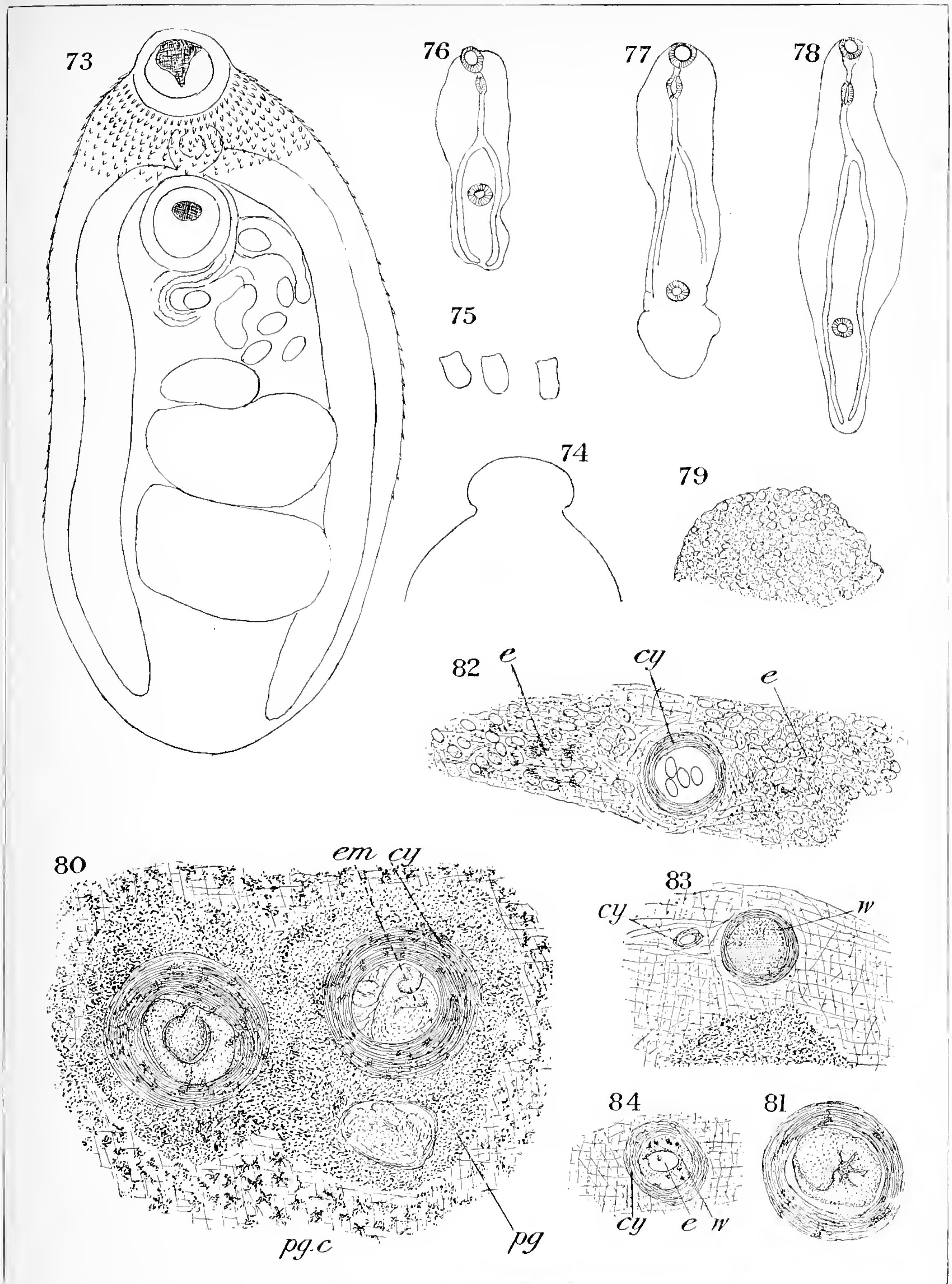
68. Lateral view, alcoholic. × 20.
69. Ventral view, sketch of specimen in oil of thyme. × 70.
70. Ventral view of anterior end. × 100.

Distomum sp. from Prionotus carolinus.

71. Outlines of two specimens, life. × about 50.

Distomum sp. from Stenotomus chrysops.

72. Ventral view, life, spines not shown. × 68.
    a', Spherical bodies with concentric structure.



Distomum sp. from Paralichthys dentatus.

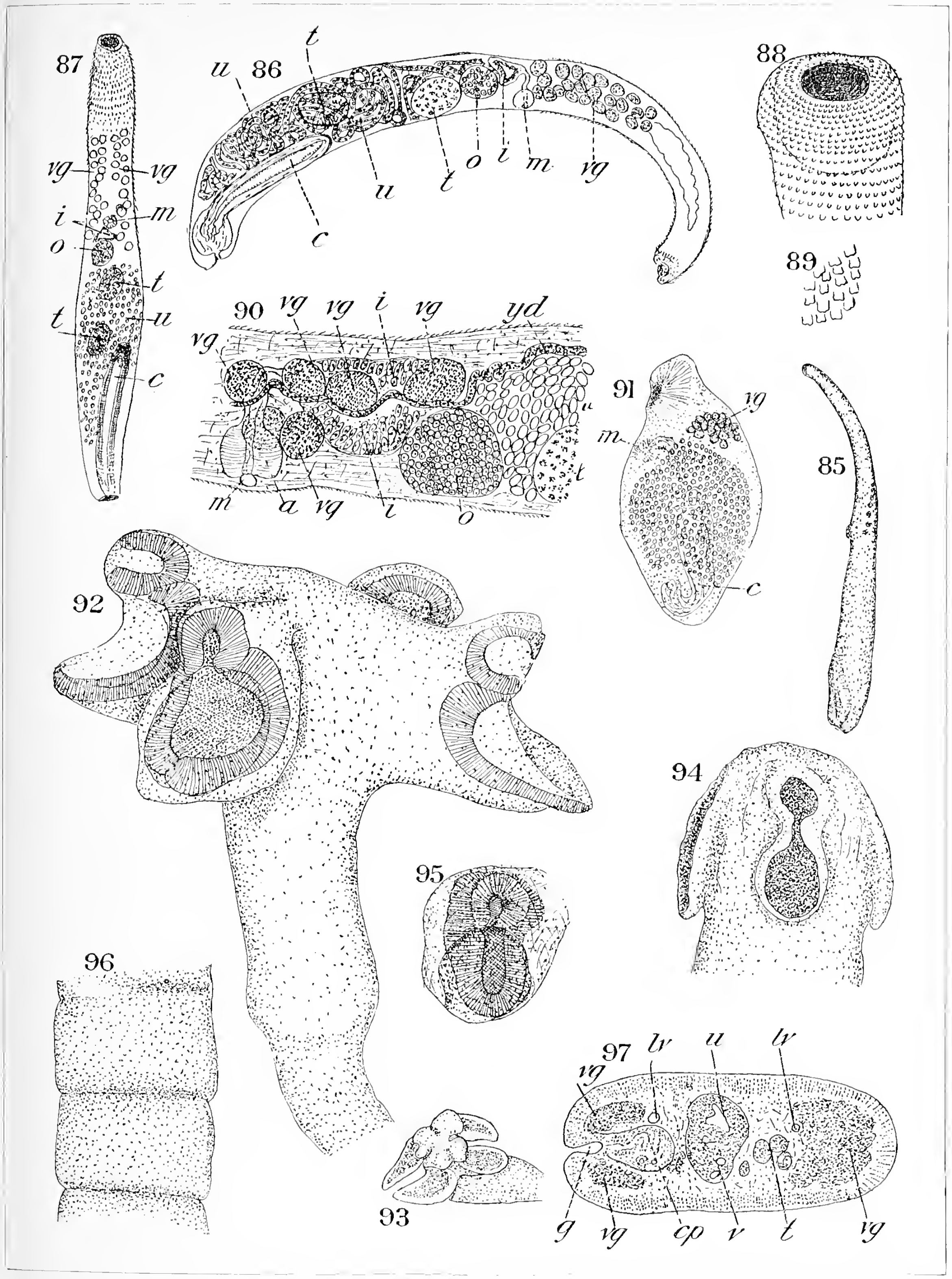
73. Ventral view, life. × 100.
74. Outline of anterior end, dorsal view, life. × 100.
75. Flat scale-like spines from body. × 100.

Immature distoma encysted in skin of Tautogolabrus adspersus.

76, 77, 78. Outlines of three individuals, life. × 100.
79. Anterior end, dorsal, life; sketch showing irregularly papillose structure. × 100.
80. Cysts with young distoma, optical section, life. × 100.
em, Young distomum; *cy*, connective-tissue cyst; *pg*, mass of pigment accumulated about cysts; *pg.c*, pigment cells.
81. Single cyst, optical section, life. × 100.

Encysted ova, from Morone americana.

82. Ova and pigment, from serous coat of liver. × 300.
cy, Connective-tissue cyst containing ova; *e*, ova with accumulation of pigment.
83. Cysts from same. × 300.
cy, Cyst formed about a single ovum; *w*, cyst containing waxy secretion.
84. Single cyst from same. × 440.
e, Ovum; *w*, waxy secretion; *cy*, connective-tissue cyst.



Gasterostomum arcuatum sp. nov. from Sarda sarda.

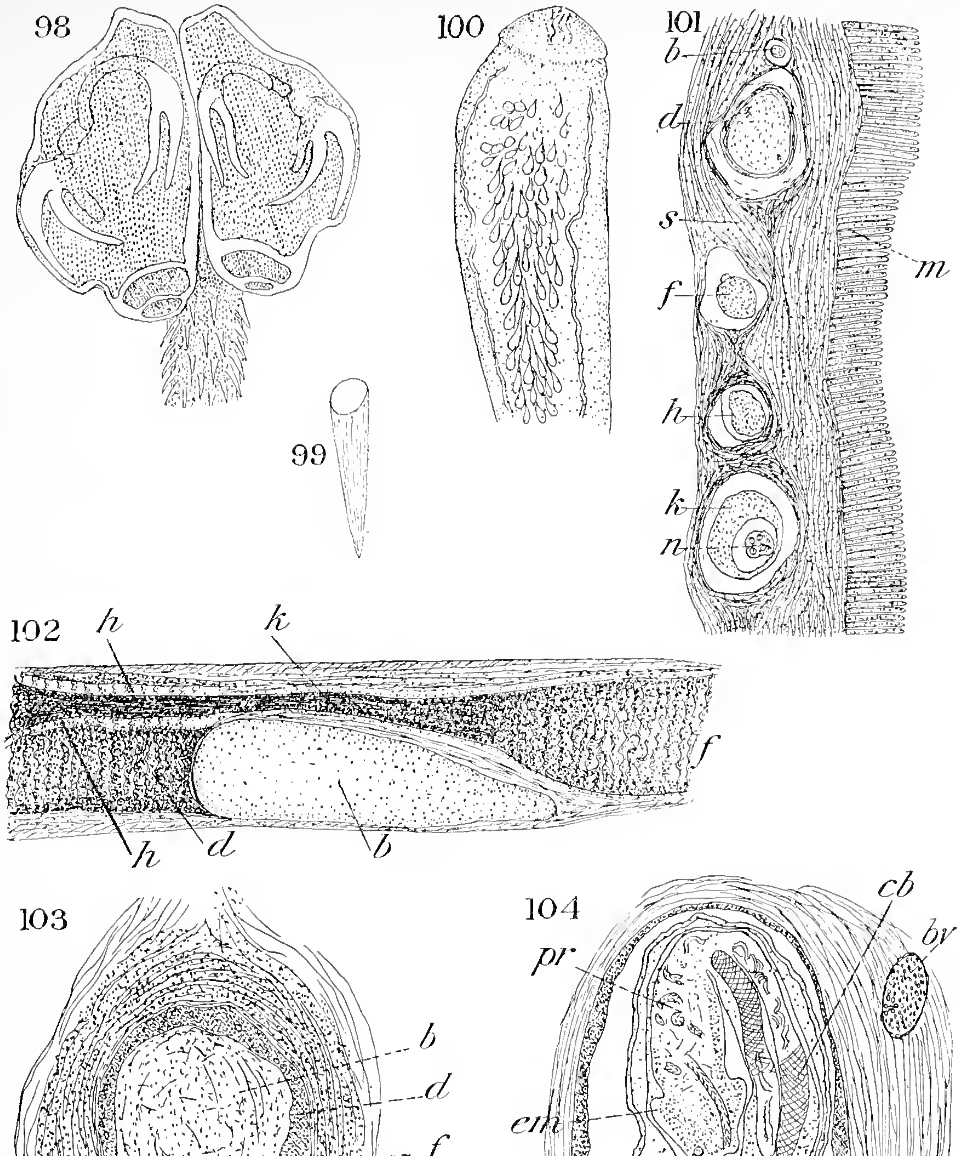
85. Lateral view of small specimen. × about 70.
86. Lateral view of larger specimen. × 70. *m*, Mouth.
87. Ventral view, diagrammatic. × 50. *m*, Mouth.
88. Anterior end. × 260.
89. Flat, scale-like spines from neck. × 450.
90. Median longitudinal vertical section. × 180. *m*, Mouth; *a*, ventral sucker (pharynx).

Gasterostomum sp. from Tylosurus marinus.

91. Lateral view. × 70. *m*, Mouth.

Calyptrobothrium occidentale sp. nov. from Tetranarce occidentalis.

92. Head and neck of small specimen, life. × 68.
93. Front view of same, alcoholic. × 24.
94. Head of large specimen, alcoholic. × 24.
95. Single bothrium (see fig. 92), life. × 68.
96. Posterior segments of small specimen, life. × 68.
97. Transverse section of one of the posterior segments of large specimen. × 80. *lv*, Longitudinal vessel.



Platybothrium sp. from Sphyrna zygæna.

98. Lateral view of head, life. × 100.
99. Spine from neck. × 750.

Larval cestode from Sarda sarda.

100. Anterior end; specimen, cleared in acetic acid, showing pyriform bodies. × 80.

Larval cestodes from Pomatomus saltatrix.

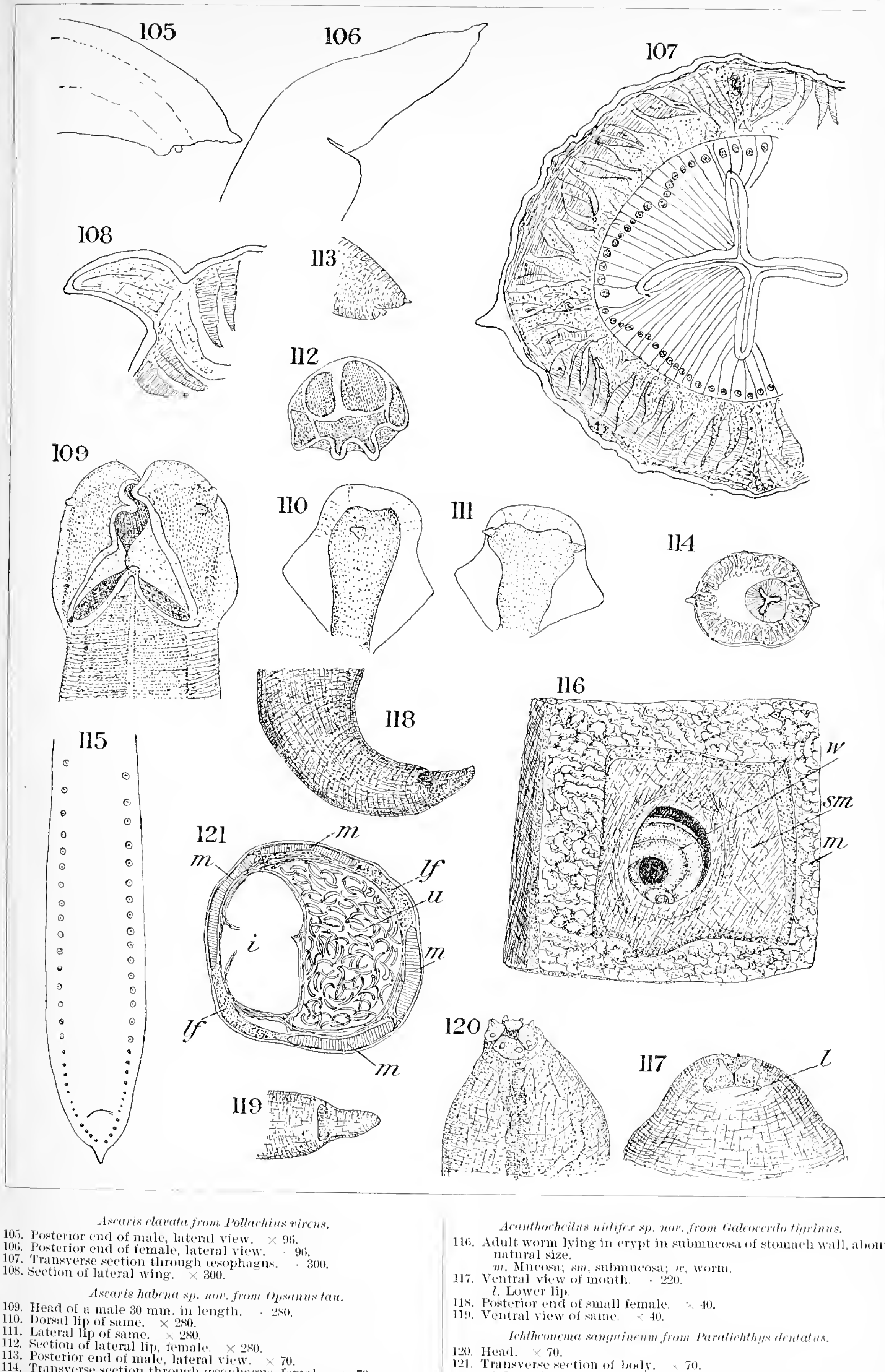
101. Section of submucosa and mucosa of stomach, containing cysts. × 24.
b, Small blastocyst surrounded by connective tissue cyst; *d*, larger blastocyst with cyst; *f*, blastocyst; *h*, blastocyst; *k*, blastocyst; *n*, larval Rhynchobothrium, transverse section of neck, showing the four proboscides in section; *m*, mucosa; *s*, submucosa.

Tumor in submucosa of pylorus of Galeocerdo tigrinus.

102. Portion of pylorus cut open longitudinally. About natural size.
b, Tumor; *d*, lumen of pylorus occluded by tumor; *f*, lumen behind tumor; *hh*, ridges of modified mucous membrane forming a channel which leads to *k*, a narrow passage leading past the tumor.

Cysts from stomach wall of Centropristes atrarius.

103. Cyst from submucosa of stomach. × 220.
b, Blastocyst; *bv*, blood vessel; *d*, granular coat; *f*, thin layer of connective tissue; *h*, loose connective tissue with numerous nuclei; *k*, normal connective tissue.
104. Section of cyst with blastocyst and larval Rhynchobothrium. × 80. *bl*, Blastocyst; *bv*, blood vessel; *cb*, proboscis-bulb; *cy*, connective tissue cyst; *em*, head of larval Rhynchobothrium; *pr*, proboscis.



Ascaris clavata from Pollachius virens.

105. Posterior end of male, lateral view. × 96.
106. Posterior end of female, lateral view. × 96.
107. Transverse section through œsophagus. × 300.
108. Section of lateral wing. × 300.

Ascaris habena sp. nov. from Opsanus tau.

109. Head of a male 30 mm. in length. × 280.
110. Dorsal lip of same. × 280.
111. Lateral lip of same. × 280.
112. Section of lateral lip, female. × 280.
113. Posterior end of male, lateral view. × 70.
114. Transverse section through œsophagus, female. × 70.
115. Plan of arrangement of anal papillæ.

Acanthocheilus nidifex sp. nov. from Galeocerdo tigrinus.

116. Adult worm lying in crypt in submucosa of stomach wall, about natural size.
m, Mucosa; *sm*, submucosa; *w*, worm.
117. Ventral view of mouth. × 220.
l, Lower lip.
118. Posterior end of small female. × 40.
119. Ventral view of same. × 40.

Ichthyonema sanguineum from Paralichthys dentatus.

120. Head. × 70.
121. Transverse section of body. × 70.
i, Intestine; *lf*, lateral field; *m*, muscles; *u*, uterus with young.

Contributions from the Biological Laboratory of the U. S. Fish Commission, Woods Hole, Massachusetts.

BIOLOGICAL NOTES.

(No. 1. Issued July, 1900.)

For the purpose of providing a repository for current observations and a means for the prompt publication of useful notes on the marine life of southern New England, special papers will be issued from time to time containing brief articles presented by persons pursuing investigations at or near Woods Hole. Communications embodying new observations on the habits, spawning, migration, distribution, abundance, structure, etc., of the animals of the surrounding waters are solicited, and notes on the aquatic vegetation of the region are also desired. Due credit for the contributions will be given.

Phoca vitulina, *Harbor seal.*

Seals are found regularly in the vicinity of Woods Hole, appearing about the middle of October and remaining until about the first of May. They are usually first noticed at the head of Buzzards Bay, on Scraggy-neck Ledge, where a herd of 100 or 150 may be seen off and on through the winter. A smaller herd frequents Lackey Bay. Several seals are caught each year by Mr. Edwards in fyke nets set at the head of Great Harbor; the record for the past two seasons being one in each of two fykes on January 21, 1899, and one on March 20, 1900. In the winter of 1898–99, one was taken with the iron ring from the end of a lobster pot tightly encircling its neck; the ring had cut its way through the soft tissues and partly severed the trachea. The seals enter the fykes almost always at night, and are dead when found, with their heads forced through the first funnel. In 1887, during two weeks in January, 21 were taken by Mr. Edwards in gill nets set in the harbor, 8 being obtained alive; all were caught at night, mostly during stormy weather. Of late, the seals have not entered the gill nets. They weigh from 80 to 90 pounds, and dissection has shown that they subsist chiefly on cunners. (H. M. Smith.)

Pseudopleuronectes americanus, *Winter Flounder.*

Mr. S. R. Williams, of Harvard University, has furnished the following data: The young of the winter flounder were abundant from the time of his arrival at Woods Hole, June 4, 1899, until June 16 and 17, after which they were less frequently taken. There are apparently two sizes at which metamorphosis takes place. The smaller "turns" when about 8 mm. in length; the larger when nearly twice as long, 14 or 15 mm. in length, and there seem to be no fishes of intermediate length undergoing metamorphosis. All young fish over 8 mm. in length may be depended upon to reach a length of 14 mm. before turning. This interesting fact is based upon an examination of 1,000 small fish, of which about two-thirds were of the smaller variety and one-third of the larger. The young fish were much more abundant in 1899 than at any time during the summer of 1898. (H. C. Bumpus.)

Pseudopleuronectes americanus.

During the winter of 1897–98 my attention was called to the large number of flat-fish bearing blotches of color on the lower side, which were on sale in the Providence market. These "black-bellied" flat-fish were quite abundant in Greenwich Bay, Rhode Island, and during March, 1898, an assistant succeeded in collecting from them a quantity of eggs and milt. The fertilized eggs were sent to the hatchery at Woods Hole, where they were hatched, and the fry were planted at Waqnoit

Bay, a small inlet about 8 miles to the eastward of Woods Hole. The fact that several black-bellied flat-fish were taken at Waquoit during the early months of the year 1900 is of special interest, since it would seem to indicate that the blotching of the lower side of the fish is an hereditary character, and it also gives strong evidence that the efforts of the Commission to increase the number of shore fishes by artificial propagation are by no means futile. Mr. Vinal N. Edwards states that he has seined at Waquoit for nearly thirty years, and that he never found a flat-fish from that locality that was either spotted or dark on the lower side until February and March of the present year. The specimens which we have taken this year are all between 7 and 8 inches in length—that is, they are two years of age. We have not taken a single specimen, either less than two years of age or more than two years of age, that has any marking upon its lower surface. It would seem, then, that these black-bellied specimens have grown from the fry planted at Waquoit in the early spring of 1898. (H. C. BUMPUS.)

Pseudopleuronectes americanus.

A male in spawning condition, 14 inches long, taken in a fyke net in Waquoit Bay, February 23, 1900, has its eyes and mouth on the left side—the first of the kind I have taken (V. N. EDWARDS.)

Bothus maculatus, *Sand-dab; Window-pane.*

In 1899 Mr. Williams found the "window-pane" not so abundant as in 1898. The growth of these fish is somewhat remarkable. Fish skimmed from the surface and placed in glass vessels increased from 10 to 21 mm. in ten days. (H. C. BUMPUS.)

Paralichthys oblongus, *Four-spotted Flounder.*

While seining at the head of Great Harbor on June 27, Mr. Williams caught a young four-spotted flounder about 2½ inches in length. This capture is of considerable interest, as the young have never before been taken at Woods Hole, although they were taken at Menemsha in 1886. (H. C. BUMPUS.)

Tautoga onitis, *Tautog.*

During the winter of 1898–99 many tautog perished because of the formation of anchor ice in the beds of Vineyard Sound, where they are accustomed to spend the winter. A great many bodies were washed up on the shore and were picked up by the fishermen and sent to market. In the summer of 1899 the tautog were very much less abundant than during the previous years, and there were no fishermen who found it profitable to fish for them. One is naturally inclined to attribute their present scarcity to the mortality mentioned. The winter of 1899–1900 was exceptionally mild and no dead tautog were seen along the shores. (H. C. BUMPUS.)

Cryptacanthodes maculatus, *Ghost-fish.*

On January 19, 1900, a ghost-fish, 11 inches long, was taken at Edgartown and sent to the Commission. Only two other specimens are known to have been taken in this vicinity, one in 1875 the other in 1896. (V. N. EDWARDS.)

Leptocephalus conger, *Conger Eel.*

During the first half of November, 1899, conger eels were plentiful and very large, and some were taken almost every day. On the morning of November 9 two, weighing 12 pounds each, were caught. (V. N. EDWARDS.)

Fistularia tabacaria, *Trumpet-fish.*

A large specimen of this straggler from the tropics was seined by me as late as November 1, 1899. It was 20 inches long, exclusive of the tail. (V. N. EDWARDS.)

Exocœtus heterurus, *Flying-fish.*

In 1886, and possibly on one previous occasion, this fish has been detected at Woods Hole. One 12 inches long was seined at Menemsha Bight, Marthas Vineyard, on August 1, 1899; at the same place another, somewhat smaller, was caught in a fish trap on August 21. (H. M. SMITH.)

Rachycentron canadum, *Cobia; Crab-eater.*

This fish has rarely been observed in recent years, and was much commoner twenty-five years ago than at any time since; only small (5 or 6 pound) specimens have heretofore been seen. On July 18, 1899, a fine example 4¾ feet long, and weighing 60 pounds, was caught in the Fish Commission trap in Buzzards Bay and retained alive until August 31. (H. M. SMITH.)

Tetragonurus cuvieri, *Square-tail; Sea-raven.*

This very rare species, described from Nice in 1810, was until 1890 known only from the coast of southern France and the Madeira Islands. The original describer considered it a deep-water form that approached the coasts only for spawning purposes. On November 10, 1890, the species was added to the western Atlantic fauna by the capture of a specimen at Woods Hole. The taking of another at the same place, on August 1, 1899, is interesting and unexpected; the fish, about 1½ inches long, was found under a mass of floating rock-weed in Vineyard Sound. (H. M. SMITH.)

Alutera monoceros, *File-fish.*

The detection of this very interesting East Indian species on our coast at Woods Hole in August, 1898, was referred to in a recently issued paper by the writer. While possibly this is the species recorded from Cuba by Parra in 1787 and by Poey in 1863, the evidence is far from conclusive. The seining of a second specimen, 8½ inches long, at Menemsha Bight, on August 1, 1899, is now recorded. (H. M. SMITH.)

Gadus callarias, *Cod.*

On the conclusion of the fishing for brood cod in the fall of 1899, 14 cod weighing from 4 to 6 pounds, taken with hand-lines off Nomans Land or Nantucket, were inadvertently left in the well of the *Grampus* and not discovered until April, 1900. These fish were placed in the well not later than November 18, possibly some days before. During this time they had not been fed, and had only such food as came through the holes in the well. When released in Gloucester harbor on April 16, they were found to be lively and strong, although somewhat emaciated, and it was noticed that their backs and sides were much darker than normal, while the belly was unusually light-colored. (E. E. HAHN.)

Gadus callarias, *Cod.*

On January 11, 1899, 2,260,000 recently hatched cod were planted in Eel Pond, at Woods Hole. The fish were kept under observation until June 20, 1899, by which time only a few remained in the pond. The following extreme and average lengths were exhibited by specimens seined at intervals of about one week during April, May, and June:

Date.	Extreme length.	Average length.	Date.	Extreme length.	Average length.
	mm.	*mm.*		*mm.*	*mm.*
April 8	29 to 38	32.9	May 19	45 to 53	47.7
April 17	33 47	38.8	May 25	58 68	64.0
April 25	34 49	40.0	June 6	71 76	73.5
April 28	36 56	41.0	June 12	71 73	72.0
May 5	31 44	37.4	June 20	73 77	75.0
May 13	35 51	42.8			

(H. M. SMITH.)

Solen ensis.

In the early evening of June 20, 1899, a large number of young razor-clams, measuring from 1 to 10 mm. in length, were caught in the auftrieb at Wickford, R. I. These clams, some of them nearly half an inch long, do not, of course, possess a ciliated swimming organ. The larger specimens had shells which were hard and comparatively heavy, and all fell directly to the bottom when transferred from the tow-net to a dish of water. Occasionally, however, they arose and swam to the surface, propelling themselves rapidly by a curious kicking movement of the very powerful foot. When they were taken the evening was cloudy and a high wind was blowing from the south. The temperature of the water was 72° F., and the density at the surface was 1.0202. (A. D. MEAD.)

Naushonia crangonoides.

A beautiful specimen of this rare decapod was found in the sand on the shore of Ram Island, near Woods Hole, July 22, 1899. It was a female bearing bright orange-colored eggs and nearly 1½ inches in length. Its behavior in captivity was much like that of *Gebia* and *Callianassa*. It was found below a crater-like depression, evidently of its own making, and lived in the laboratory in a shallow dish of sea water until December 17, 1899. The type specimen of this crustacean was taken by Prof. H. C. Bumpus near the "Gutter" on Naushon Island, February 13, 1893, and is now in the collection of the Essex Institute. The specimen captured in 1899 is the only other one known. (G. M. GRAY.)

Homarus americanus, *Lobster*.

In the fall of 1899 about 20 lobsters were left in a car in the "basin" at the Fish Commission wharf. Near the end of March 1900, when the car was opened, all seemed to be in a perfectly healthy condition. (GEORGE M. GRAY.)

Nereis limbata.

This annelid, which is usually seen only at night, when attracted by artificial light, was observed in great numbers in the daytime at Wickford, R. I., on May 31, 1899. The house-boat laboratory of the Rhode Island Fish Commission contains a "well" 12 feet wide and 30 feet long, entirely open below. In this space myriads of *Nereis* were swimming in their characteristic excited manner and discharging their eggs during the whole forenoon of May 31. It is difficult to give an adequate idea of their great numbers. A solid quart or more taken out with a scoop net made no appreciable difference in the appearance of the swarm. Throughout the day the sun was shining brightly, and yet the worms behaved exactly as one sees them by the light of a lantern at night. The males were more abundant than the females, and swam with their peculiar swift, gyrating movement, or in small circles, while the females swam more slowly, and after discharging their eggs, collapsed and sank to the bottom. The water was literally full of their eggs, which were fertilized and were developing normally. The worms were first observed at 7 o'clock in the morning, and remained with little decrease in numbers until about 10 o'clock, when they became gradually fewer. At 2 p. m., however, hundreds were still present in the "well." In the water outside the house-boat only a very few were seen even in the early forenoon. Although these annelids may be taken almost any night in greater or less abundance, the singular pheuomenon just described has not been repeated. (A. D. MEAD.)

Nereis virens.

On March 24, 1900, "clam worms" were seen swimming in the shallow water along the shore of Monamesset Island, near Sheep Pen Cove. Nearly 300 specimens were captured in about an hour's time. As the tide rose the worms burrowed down into the sand, several being taken when the head and a portion of the body were hidden beneath the surface. On the morning of March 26, when the same locality was visited again, only 2 specimens were to be seen; but an hour later, soon after 12 o'clock, when the tide had turned and was rising, about 150 were taken. On the following morning, as the tide was running out, only a single specimen could be found, but after the tide had turned they were so abundant that more than 500 were picked up in an hour. These worms schooled in the shallow water for more than an hour, and were seen in other localities also. Although the greater number were of the characteristic olive-green color, some were dull yellowish-orange. After the worms were placed in a bucket they discharged their sexual products until the water looked like milk. On subsequent days only scattering individuals were taken. (GEORGE M. GRAY.)

Chætopterus pergamentaceus.

During the extremely low tides of December, 1899, hundreds of these singular worms were killed by the cold. (H. C. BUMPUS.)

Thyone briareus.

There has been some lack of definite information in regard to the habits of the littoral echinoderms during cold weather. In December, in 1899, I visited the colony of these holothurians at Hadley Harbor, and found them shriveled up into contracted spheres, the tentacles completely withdrawn, and the animals hidden several inches below the surface. On March 30, 1900, I found them just below the surface, the posterior end of the body extended, and the respiratory function evidently going on with characteristic energy, but the anterior end of the body was still deeply buried in the mud, and not a single specimen was found with expanded arms. (GEORGE M. GRAY.)

Sertularia argentea.

On April 6, 1900, several specimens, with ripe gonophores, were dredged off Nobsque Point. Only the dead stalks are found during the summer months. (GEORGE M. GRAY.)

ADDITIONS TO THE FISH FAUNA IN 1899.

The summer and fall of 1899 yielded an extraordinary number of species new to the Woods Hole region, raising the list of known forms to 240. Most of the species were observed only in Katama Bay, a small body of shallow water separating the eastern end of Marthas Vineyard from Chappaquiddick Island. The 16 fishes whose names follow are all southern species, and most of them were not previously known north of Florida. (H. M. SMITH.)

Muræna retifera Goode & Bean. *Moray.*

Described from the coast of South Carolina in deep water, and heretofore known only from that locality. A specimen taken in a lobster pot near Tuckernuck Island on July 25, 1899, measured 6 feet 2 inches in length, 18 inches in circumference, and weighed 39 pounds. This huge eel was subsequently exhibited in New Bedford as a "sea serpent." It was identified by Dr. H. C. Bumpus.

Holocentrus, sp. *Squirrel-fish.*

A young squirrel-fish, differing from the common Florida and West Indian species, *H. ascensionis*, and apparently representing one of Poey's imperfectly described Cuban species, was taken in Katama Bay on September 1. There is no other record of the occurrence of a squirrel-fish north of Florida.

Apogon maculatus (Poey). *King-of-the-Mullets.*

This species has been recorded from Florida, the West Indies, and Brazil. It is not rare on the Snapper Banks off the west Florida coast, and has frequently been found in the stomachs of snappers and groupers. There is no record of its occurrence anywhere on our coast north of Key West, although a related species, *Apogon imberbis* (Linnæus), was once reported from Newport, R. I., by Cope. On September 1, 1899, 6 specimens were taken at one seine-haul in Katama Bay, and on September 16 5 more were caught at one set at the same place.

Epinephelus morio (Cuvier & Valenciennes). *Red Grouper.*

This well-known Florida and West Indian food-fish is known from Virginia, and was also recorded from New York by the describers and by De Kay, although no one since the latter's time has reported it so far north, and he himself relied on the testimony of fishermen. The detection of the fish in the vicinity of Woods Hole in 1899 is now announced, 5 specimens being taken in Katama Bay on September 1, and 2 on September 16; these were all young, from 3 to 4 inches in length.

Epinephelus adscensionis (Osbeck). *Rock Hind.*

Previously known range, Florida Keys to Brazil, Ascension Island, and St. Helena Island. One small example was taken by the Fish Commission in Katama Bay on September 19, 1899.

Garrupa nigrita (Holbrook). *Black Jew-fish.*

A number of small specimens found during September in company with *Epinephelus niveatus* and bearing a remarkable superficial resemblance to that species, are with some hesitation identified as the black jew-fish, the young of which is undescribed. The species ranges from South Carolina to Brazil.

Eupomacentrus leucostictus (Müller & Troschel). *Cocky-pilot.*

The hitherto known range of this species, which was described from the Barbadoes in 1848 in Schomburgk's history of that island, was the West Indies to Key West and the west coast of Florida. Between August 30 and October 4, 1899, 9 small specimens of uniform size were taken on five different days in Katama Bay.

Teuthis hepatus Linnæus. *Surgeon-fish; Tang; Lancet-fish.*

Teuthis cœruleus (Bloch & Schneider). *Blue Surgeon; Blue Tang.*

Teuthis bahianus (Castelnau). *Barbeiro.*

These three species are recorded from Florida, the West Indies, and Brazil; the first has been taken as far north as Charleston, S. C. During August, September, and October, 1899, all of them were found in some numbers in Katama Bay, and about 50 were obtained on seven different occasions. The last were secured on October 4, when the three species were represented in one seine-haul. About half the specimens are referable to the common species (*T. hepatus*). All are small, although those last taken exhibit a slight increase in size compared with those caught early in September.

Mycteroperca bonaci (Poey). *Marbled Rock-fish; Black Grouper.*

This fish is known from the west coast of Florida and about Key West, whence its range extends through the West Indies to Brazil. One specimen, 5 inches long, was seined in Katama Bay on September 19, 1899.

Mycteroperca interstitialis (Poey).

Ten specimens of a small grouper were obtained in Katama Bay in September and October. They are apparently referable to this species, known only from Cuba, but may be the young of some other species.

Lactophrys triqueter (Linnæus). *Trunk-fish.*

This fish inhabits the West Indies, Florida, and the Bermudas, but has not been previously reported from Massachusetts, although the common trunk-fish, *Lactophrys trigonus* (Linnæus), has been known from the region for many years and is taken at Woods Hole every season. A number of small specimens of *L. triqueter* were obtained in 1899; several collected in 1897 and earlier years had been identified as *L. trigonus.*

Lactophrys tricornis (Linnæus). *Trunk-fish; Cow-fish.*

This widely distributed species has been reported as far north on our coast as Chesapeake Bay, whence its range extends to the Gulf of Mexico, West Indies, Brazil, and west Africa. Its occurrence in the Woods Hole region, in company with the following species, was noted for the first time in September, 1899, when it was found on four or five occasions in Katama Bay. All of the specimens were small. On November 6, 1899, a fish 15½ inches long was washed ashore at Cuttyhunk.

Scorpæna plumieri Bloch. *Scorpion-fish.*

This species, which is common from the Florida Keys to Brazil, has not been recorded north of Key West. On seven days in August, September, and October, 1899, the fish was found at Woods Hole, and 20 small specimens were taken.

Scorpæna grandicornis Cuvier & Valenciennes. *Scorpion-fish; Lion-fish.*

The normal range of this species is southern Florida to South America, in shallow water. One small example was secured in Katama Bay on September 29.

RIGHT LATERAL VIEW OF THE ENTIRE SKELETON OF *Micropterus dolomieu.*

Reduced about one-third the natural size, and reproduced from a photograph made by the author from the specimen. In some places the ligamentous attachments are not entirely removed, and the bones in some few cases are slightly dislodged, as may be seen in the dorsal fin-rays, abdominal ribs, and the ventral fins.

THE SKELETON OF THE BLACK BASS.

By Dr. R. W. SHUFELDT.

Upward of twenty years ago a special interest was taken by me in the osteology of the large-mouth black bass (*Micropterus salmoides*) from having discovered in the skeletons of one or two specimens of that species a pair of free ribs articulating with the base of the skull or occiput. As this peculiar anatomical character had never been noted by me before in any of the true bony fishes (*Teleostei*), it was at the time deemed worthy of scientific record, and so, under the title of "Osteology of the large-mouthed black bass (*Micropterus salmoides*)," there was printed in Science, of Cambridge, Mass., May 2, 1884, a brief account of this interesting point in the skeleton of *Micropterus*.

It was there stated that this peculiarity "consists in a pair of freely articulated ribs at the base of the occiput. Their heads are received in a shallow facet on either side situated just above and rather internal to the foramen for the vagus nerve. Immediately below each rib occurs the projection of bone that bears upon its entire posterior aspect one of the pair of articular condyles for the first free vertebra of the spinal column. Still beneath these condyles is seen the conically concave facet for articulation, with a similarly formed surface occurring on the centrum of the vertebra just mentioned, and the one which I believe would be described as the atlas." This pair of ribs is directly in sequence with the abdominal ribs on either side. Their occurrence in this situation might be accounted for by saying that several of the anterior vertebræ of the column had been absorbed by the occipital elements. Mr. Bridge found such a condition in *Amia*, though no free ribs were present (*Journ. Anat. and Phys.*, XI, 611, London, 1877). In further commenting upon this it was added that "in the cranium of *Micropterus*, however, I should think that this would be highly improbable. Both the first and second vertebra of the spinal column of this bass support each a pair of free ribs, and a mid-series of the other abdominal ribs bears epipleural appendages. Dr. Günther states, in his account of the osteology of the *Teleostei*, in the article 'Ichthyology' of the Encyclopædia Britannica (vol. XII, 9th ed.), that 'the centrum of the first vertebra or atlas is very short, with the apophyses scarcely indicated. Neither the first nor the second vertebra has ribs.' I have a yellow perch (*Perca flavescens*) in my possession where both of these vertebræ support a pair of free ribs." In conclusion, I added that "should an examination of the young of the black bass show that none of the anterior vertebræ of the column were included with the occipital segments, but that these ribs are truly occipital ribs, then they become of interest from several points of view."

This discovery was made in March, 1884, and, as has been noted above, was published the following May, and attracted the attention of no less a distinguished

authority than Mr. McMurrich, who at once noticed it in the same periodical (Science, No. 69, 1884), but his remarks possessed upon this point but little value, inasmuch as he had not taken the trouble to examine a specimen before printing them, and therefore had no material before him when he wrote. Nevertheless they were replied to by me in another contribution to Science (vol. III, No. 72, June 20, 1884) under the title of "Osteology of *Micropterus salmoides*," and this time a figure of the left lateral view of the cranium of this species of fish was published that showed the pair of free ribs on the occiput.

Moreover, in this communication the literature of the subject was reviewed, greater detail added in regard to these free *occipital ribs*, pointing out that Mr. McMurrich was entirely wrong in his conceptions of their morphology, and that "Dr. Sagemehl, in his valuable paper on the cranium of *Amia* (*Morphologisches Jahrbuch*, IX), is very explicit in what he says about the coössification of the three vertebræ with the basi-occipital of this ganoid; and if this author had been aware of such a state of affairs as I here figure in any of the Teleostei, he certainly would have brought it forward in connection with

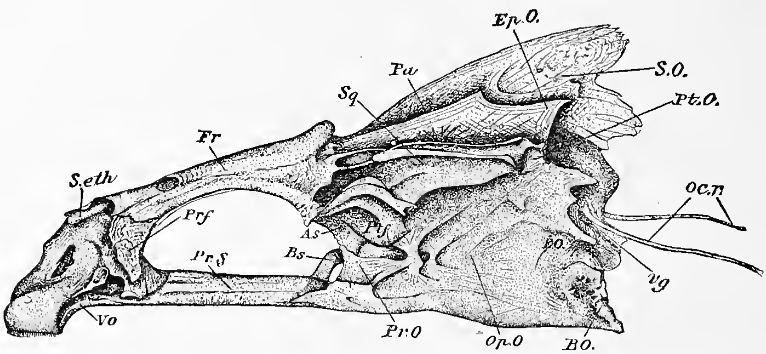


FIG. 1.—Left lateral view of cranium of *M. salmoides*, showing a pair of ribs at the occiput; life size from nature, by the author, from his own dissections. *S. eth.*, supraëthmoid; *Fr.*, frontal; *Sq.*, squamosal; *Pa.*, parietal (not well in sight); *Ep. O.*, epiotic; *S. O.*, supraoccipital; *Pt. O.*, pterotic; *oc. r.*, occipital ribs; *vg.*, foramen for vagus nerve; *E. O.*, exoccipital; *B. O.*, basi-occipital; *Op. O.*, opisthotic; *Pr. O.*, proötic; *Ptf.*, postfrontal; *As.*, alisphenoid; *Bs.*, basisphenoid; *Pr. S.*, parasphenoid; *Prf.*, prefrontal; *Vo.*, vomer.

the discussion of that subject. They are two very significant facts, that these ribs in *Micropterus* articulate *beyond* the vagus foramen and that they are apparently constant. I have since found similar structures in a specimen of *Orcynus thynnus*, and rather suspect it in the *Scombridæ*."

The figure that illustrated this letter to Science reappeared in my memoir entitled "Outlines for a Museum of Anatomy," which was published by the Bureau of Education at Washington, D. C. (Department of the Interior, 1885, p. 60, fig. 6). This figure is introduced in the present memoir as fig. 1, as it illustrates a very important part of the skeleton of the black bass.

Beyond giving this cut, however, there was nothing especially added to our knowledge of the osteology of this bass in my "Outlines for a Museum of Anatomy," further observations being reserved until my more extensive memoir was published by the U. S. Commission of Fish and Fisheries, in 1885, entitled "The Osteology of *Amia calva*, including certain special references to the skeleton of Teleosteans."

In this work very considerable reference was made to the skeleton of *Micropterus salmoides*, and six figures were given in the plates illustrating it. Nevertheless the

paper as a whole was devoted to the osteology of *Amia*, and what I had to say there about that of the black bass was only by way of comparison. While I shall take advantage of those previous researches, the present memoir is primarily intended to give an account of the skeleton of this well-known bass in its entirety, and, as will be observed, a full-page plate is likewise here given which presents a side view of the entire skeleton of the small-mouthed black bass (*Micropterus dolomieu*). This is from a photograph made from a specimen prepared by Dr. Jacob L. Wortman. Fig. 27 of my *Amia* paper gives a left lateral view of the skull of *Micropterus salmoides*, natural size, being reproduced from a drawing made by me from my own dissections. This figure is here reproduced as fig. 2 of the present memoir There is also given in

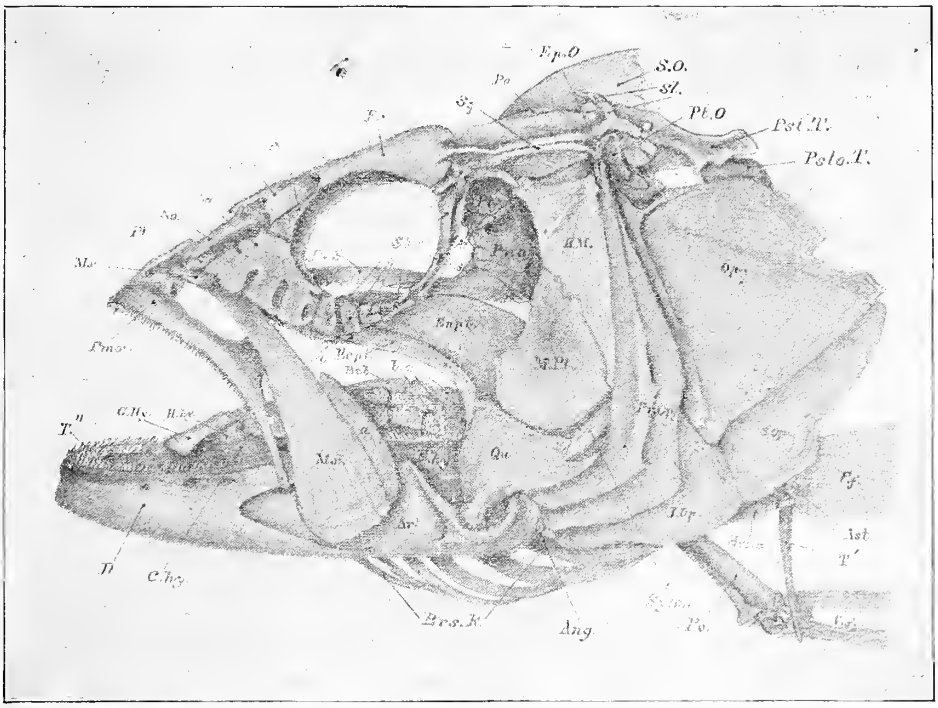


FIG. 2.—Left lateral view of skull of *M. salmoides*, with the skeleton of other parts connected with it posteriorly. Natural size and drawn from the actual specimen by the author from his own dissections, lettering the same as in fig. 3 and other figures of the memoir.

fig. 3 of the text the right lateral view of the skull of the small-mouthed black bass, a drawing made from my own dissections and not before used in any ichthyological paper. This cut will prove especially useful, inasmuch as the skull from which it was drawn is the same as that in the complete skeleton of the small-mouthed black bass in plate 44.

In no other class of backboned animals is the *skull* so large in proportion to the skeleton of the trunk or body as it is in fishes, and to this statement the black bass offers no exception. The study of the skull in osseous fishes generally was for a long time considered, even by anatomists, one of the most difficult of all problems in biology, and even at the present time it is by no means an easy task. During the last ten or fifteen years, however, owing to the numerous text-books and various manuals devoted to the elements of anatomical science, this subject has been very much simplified.

The late Sir Richard Owen, in his celebrated work on "The Anatomy and Physiology of Vertebrates," said:

> It may well be conceived. then, that more bones enter into the formation of the skull in fishes than in any other animals; and the composition of this skull has been rightly deemed the most difficult problem in comparative anatomy. "It is truly remarkable," writes the gifted Oken, to whom we owe the first clue to its solution, "what it costs to solve any one problem in philosophical anatomy. Without knowing the what, the how, and the why, one may stand, not for hours or days, but weeks, before a fish's skull, and our contemplation will be little more than a vacant stare at its complex stalactitic form."

Now, from this it will be easily appreciated that to write the "what," the "how," and the "why" of the entire skeleton of *Micropterus* would simply make a volume of several hundred pages, an achievement by no means contemplated when this brief

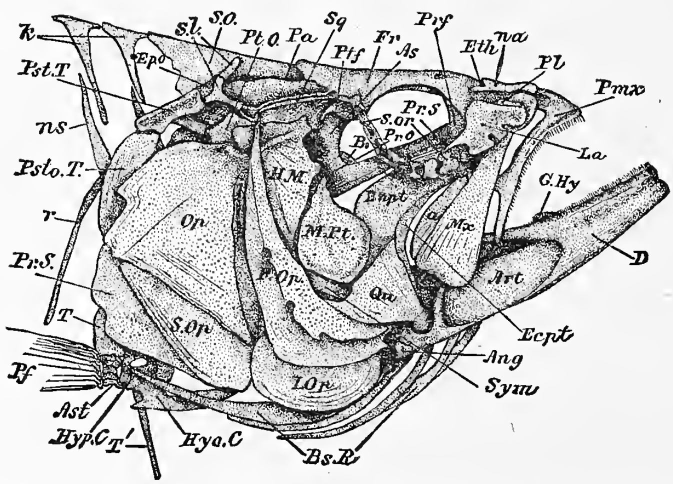


FIG. 3.—Right lateral view of skull of *M. dolomieu*, with other bones; natural size, by the author. *Pmx*, premaxillary; *Pl.*, palatine; *na.*, nasal; *Eth.*, ethmoid; *Prf*, prefrontal; *As.*, alisphenoid; *Fr.*, frontal; *Ptf.*, postfrontal; *Sq.*, squamosal; *Pa.*, parietal; *Pt. o.*, pterotic; *S. O.*, supraoccipital; *s. l.*, supralinear; *Ep. o*, epiotic; *k*, interneural spines; *La.*, lacrymal; *Pr. s.*, parasphenoid; *S. or.*, suborbital; *Pr. o.*, proötic; *Bs.* basisphenoid; *G. Hy.*. glossohyal; *D.*, dentary; *Art.*, articular; *Mx.*, maxillary; *a*, admaxillary; *Enpt.*, entopterygoid; *Ecpt.*, ectopterygoid; *M. Pt.*, metapterygoid; *Pst. T.*, posttemporal; *Pr. S.*, proscapula; *Pf.*, pectoral fin; *Hyo. C.*, bypocoracoid; *Op.*, operculum; *S. Op.*, suboperculum; *Ang.*, angular; *Sym.*, symplectic; *n. s.*, neural spine; *Psto. T.*, posterotemporal; *T.*, teleotemporal; *T'.*, lower teleotemporal; *Bs. R.*, branchiostegal rays; *P. Op.*, preoperculum; *I. Op.*, interoperculum; *H. M.*, hyomandibular; *Qu.*, quadrate; *r.*, rib; *Ast.*, actinosts; *Hyp. C.*, hypercoracoid.

memoir was undertaken. Its aim, in fact, simply consists in bringing together what I have already printed about the skeleton of this well-known and widely distributed American fish, and arranging that subject-matter in condensed monographic form, adding to it anything that may not have been touched upon in previous publications. The paper will fulfill its mission if it excites an interest anywhere in the study of the skeleton in fishes, and brings before the reader facts which will facilitate such studies, and in a way prove to be of assistance in comprehending future memoirs upon the osteology of fishes.

The best method of studying the bones composing the *skull* and *appendages* in any adult specimen of an osseous fish, apart from comparing those bones with the corresponding or analogous ones in the skull of any other animal, is to secure several perfect heads of the fish to be thus considered, as near as possible of the same size, and pre-

pare them in the following manner: One head is to be macerated in warm water until all the soft parts can be removed and the bones separate from each other, except those in the cranium. Each bone should be removed by itself, laid out to dry in a relative position it occupied in the skull, and identified if possible. For this latter operation the second skull is intended, and this one should also be partially macerated, but only so far as to moderately soften the tissues; then by the most careful dissection, *all* of these should be removed, and the entire osseous structure of the head left precisely as it is in life, in so far as the bones are concerned, the latter being held together only by their ligaments. This prepared skull is then properly dried. The third head, prepared exactly like the second, is longitudinally sawed in two by means of a very fine saw, passing to one side of the crest of the supraoccipital. By means of these two halves we are enabled to study the osseous parts of the interior of the brain case and the bones at the anterior extremity of the skull.

Fig. 3 of the present paper, as well as the illustration of the skull of the large-mouthed black bass in fig. 2, will give an idea as to how the bones are normally related to each other, and as shown in the heads of the two species of *Micropterus* prepared by the second method. Fig. 21 of my memoir on *Amia calva* shows the head, or rather the cranium, of a yellow perch (*Perca flavescens*) longitudinally bisected in order to bring into view the bones in the brain case.

As has been stated, if the head of this bass is allowed to macerate in water for a sufficient length of time all the more loosely attached bones, including the occipital ribs (fig. 1, *oc. r.*), will come away and separate from each other. This leaves the *cranium* all in one solid piece as shown in fig. 1. This, as has likewise been said, is composed of its own bony cranial segments, which require more protracted maceration to separate them. This *cranium*, and many fish possess one a good deal like it, is of a pyramidal form, the base being formed by the occiput and the apex by the vomer (*vo*), which is here produced downwards as a prominent beak, being rounded in front, and thickly studded with fine teeth upon its inferior surface.

A very noticeable feature of the cranium are the orbits. These are large and in no way separated from each other by an osseous medio-longitudinal plane standing between them. Above, they have a wide, arched roof, concave from before, backwards; while below there is but the median rod, composed principally of the vomer (*vo.*) and the parasphenoid (*Pr. S.*). Other bones entering into the bounding walls of the orbits are the frontals above (*Fr.*), the prefrontals anteriorly (*Prf.*), the alisphenoids (*As.*), and the postfrontal (*Ptf.*). On top of the cranium, behind, and occupying its hinder half, there are five conspicuous crests, a median one and two lateral ones on each side. These are well shown in fig. 1, and have been fully described in my *Amia* memoir. They vary greatly in the crania of different species of fishes, being entirely absent in some species and very prominent in others.

In the common cod (*Gadus*), for example, the median crest is thick, strong, and high, and produced far backwards and to the front to a point over the center of the orbits. Again, in the black sea-bass (*Centropristes striatus*), of which I have prepared one or two perfect skeletons, these crests are more as in *Micropterus*, but by no means exactly the same, as these two species belong to very distinct families. At the back of the cranium there are to be noticed chiefly the circular, conically concave facet for the atlas vertebra, with above it, one upon either side, the pair of zygapophysial facets for the corresponding ones on the same vertebra. These have above them

again, in the middle line, the somewhat small subcircular foramen magnum, inclined to be subcordate in outline in some specimens. Often in the common cod, always in old individuals, I believe, this first or atlas vertebra fuses with the base of the cranium, and its long neural spine runs up nearly to the top of the supraoccipital crest, being in contact with the posterior margin of the same for the entire way.

Apart from the cranium the chief features of the skull consist in the jaws, the upper one being formed by the maxillary (*Mx.*) on either side, and the præmaxillary and its fellow in front bearing the teeth (*Pmx.*) (fig. 3). These structures have been fully described in the *Amia* memoir, and the two figures there devoted to them are here reproduced as figs. 3 and 4. Attention is also invited to fig. 5, for that, taken in connection with fig. 3 of the present paper, will clearly show the relations of another group of bones of the skull, namely, the opercular bones, or those of the gill-covers (*Op.*, *P. Op.*, *S. Op.*, and *I. Op.*). Considerable attention has already been paid to these in the *Amia* contribution. In connection with them will be found the *symplectic*, a very interesting element in many bony fishes (fig. 3, *Sym.*). Then there are the bones of the *suspensorium*, connecting the cranium with the lower mandible (*H. M.*, *Sym.*, and *Qu.*). Of these, through the intervention of the *interhyal*, the hyomandibular arch has also suspended from its lower extremity the hyoid arch, while its upper and posterior extremity also articulates with the *operculum*.

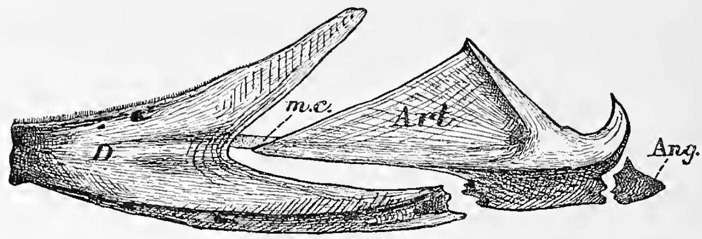


FIG. 4.—Left lateral view of mandible of *M. salmoides*. Natural size, by the author, from his own dissections, the various bones having been pulled apart to show their entire shape. *D*, dentary; *m. c.*, Meckel's cartilage; *Art.*, articular; *Ang.*, angular.

Again, in the *pterygo-palatine* arch of this bass we meet with the *metapterygoid*, the *ento*, and *ectopterygoid* and the *palatine*, and the relation of these bones to each other are shown in fig. 3 of the present paper and described in my *Amia* memoir, where also the *hyoid* and *branchial arches* of *Micropterus* have been touched upon in considerable detail. In this connection I have pointed out that the branchiostegal rays (fig. 3, *Bs. R.*) constitute the skeleton of an organ of defense to the respiratory apparatus, and that many believe that the opercular bones are merely modified branchiostegal rays.

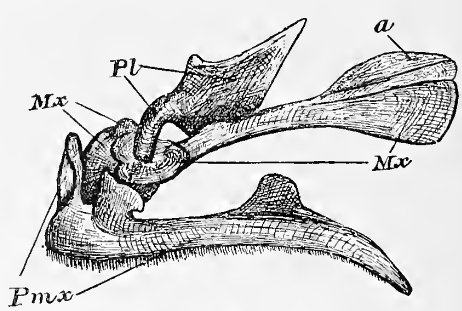


FIG. 5.—The left outer aspect of the upper jaw of *M. salmoides*, together with the bones associated with it. These latter are slightly dislodged from their normal positions, the better to show their relations. About two-thirds natural size, from the actual specimen, by the author, from his own dissections. *Mx*, maxillary; *Pmx*, premaxillary; *Pl.*, palatine; *a*, admaxillary.

Passing from the skull and its arches we come to consider the *shoulder girdle*, a sequence of bones that have been differently viewed and differently named by different ichthyologists. In my work upon *Amia calva* I have contrasted in tables these various opinions and appellations, and figured the bones, and also named a bone, the *supralinear* (*sl.*), that is in a way connected with the shoulder girdle above (see fig. 3).

In the latter, in *Micropterus*, we have a *posttemporal* (*Pst. T.*), a *posterotemporal* (*Psto. T.*), a *teleotemporal* (*T.*), a *lower teleotemporal* (*T'.*), a *hypocoracoid* (*Hyo. c.*), a *hypercoracoid* (*Hyp. c.*), and a *proscapula* (*P. Sc.*). Now the lateral or the *pectoral fins* in this bass are connected with the shoulder girdle through the intervention of four little bones, called *actinosts* (fig. 7, *Ast.*); they are very small, graded in size, and are formed somewhat like little hour-glasses or dice-boxes, being enlarged at their articular ends and constricted at the middle. Anteriorly these actinosts articulate with the posterior border of the conjoined hyper- and hypo-coracoids, while posteriorly they afford support and attachment for the bony rays of the pectoral fin (*Pf.*). In the several specimens of black bass I have dissected and others I have examined,

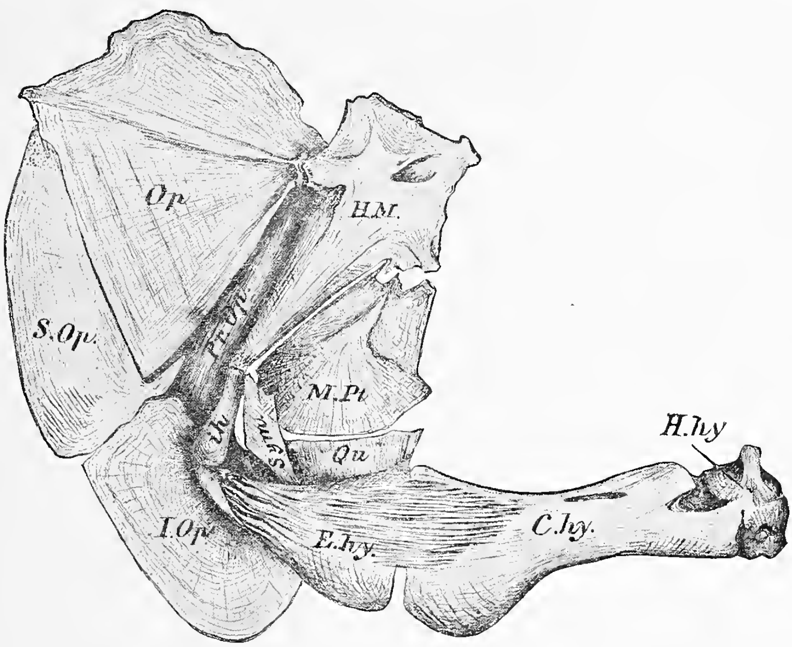


FIG. 6.—Inner aspect of opercular bones, hyoid symplectic, and other elements of *M. salmoides*. Left side, natural size, by the author, from his own dissections. *Op.*, operculum; *S. Op.*, suboperculum; *Pr. Op.*, preoperculum; *I. Op.*, interoperculum; *H. M.*, hyomandibular; *M. Pt.*, metapterygoid; *Sym.*, symplectic; *ih.*, interhyal; *Qu.*, quadrate; *E. hy.*, epihyal; *C. hy.*, ceratohyal; *H. hy.*, hypohyal. These represent the actual arrangement and relations of these bones in teleostean fishes generally.

in regard to this point, never any more or less actinosts have been found than four. Therefore it may be just as well not to slight such characters as these in our accounts of the osteology of *Pisces*, nor depict them in any other way than with extreme accuracy in figures illustrating the skeleton of any species we may be describing.

In fishes the *pelvic bones* vary very widely, both in form and position, but are never attached to the vertebral column as we find them in other and higher vertebrates. As I have elsewhere pointed out, in *Micropterus salmoides* they are represented by two separate and symmetrical bones that articulate with each other mesially by their inner edges. When thus united they form an elongated isosceles triangle, with its apex held by a ligament in the entering angle behind the proscapulæ. The outer

borders develop a raised rim, and the planes of the surfaces, contributed by the two bones superiorly on either side, look upward and outward, the reverse being the case, of course, beneath. The postero-external angles, as well as the hinder border, are thickened and undulating for the articulations of the heads of the ventral fin-rays. There is, also, a characteristic process developed mesially on this border, into the formation of which each pelvic bone takes an equal share; above it is bifid, directed upward and backward, and compressed anteroposteriorly; below it is peg-shaped and directed in the same degree forward and downward.

I fail to find any bony nodules representing the actinosts between the ventral fin rays and the pelvic bones in this fish; and the rays themselves seem to be constructed upon the same plan as the pectoral ones, being retained in their positions by firm ligaments and the skin. The outer one, however, on either side differs materially in form, being spoon-shaped, with the concavity against the next ray on its inner side. It also develops an inturned process, which curves over the next two or three rays. This double arrangement seems designed to strengthen the inner rays and assist to keep them in their position.

These *pelvic bones* are seen only in part in the accompanying figure of the skeleton of *M. dolomieu* (plate 44), but this statement does not apply to the remainder of the osteology of the body and tail of this bass.

Omitting a study of the scales of *Micropterus*, which closely resemble those of most other forms of the higher teleostean fishes, we have still to briefly consider the skeleton of the body and the skeleton of the tail.

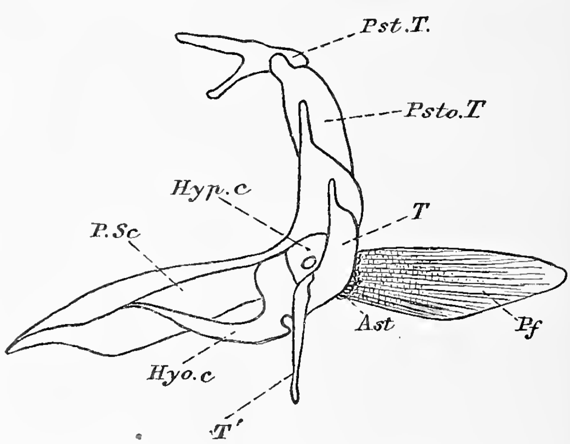


FIG. 7.—Sketch of the inner aspect of left half of shoulder girdle and pectoral limb of *M. salmoides*. *Pst. T.*, posttemporal; *Psto. T.*, posterotemporal; *Hyp. c.*, hypercoracoid; *Hyo. c.*, hypocoracoid; *P. Sc.*, proscapular; *T.*, teleotemporal; *T'.*, lower teleotemporal; *Ast.*, actinosts; *Pf.*, pectoral fin.

Counting the one from which the *urostyle* springs, *Micropterus* seems invariably to have *thirty vertebræ* in its spinal column. When I make this statement I am aware of the fact that in my paper on *Amia calva* thirty-two was the number reckoned, but after carefully recounting these on two perfect skeletons now before me, representing both species of the genus, I am satisfied that there are but thirty of these bones. Fifteen of these vertebræ belong to the abdominal portion of the column, and each one supports a pair of ribs, all of which in their turn, save the last *five pair*, have *epipleural appendages*. The atlantal pair articulate with the vertebra at the very base of the neural arch, but as we proceed backward they gradually recede from this position so as to finally spring from *beneath* the transverse processes on the under side of the vertebra. This condition is characteristic of a great many of the osseous fishes. The neural and hæmal arches of this form are completely anchylosed with the vertebral elements, and in the best-developed segments, both superior and inferior, post- and pre-zygapophyses are present.

As the accompanying figure, shown in plate 44, of the skeleton of this bass is reproduced from a photograph of a carefully dissected and dried skeleton, it will be observed that a little ligamentous material is remaining, and some of the bony fin-rays and spines are very slightly unparallel, but this fact will lead no one astray, as it is quite evident which bones have become so while the skeleton was drying. The arrangement of these *osseous fin-rays* and *interspinous bones* practically agrees with those elements as we have long known them to exist in all ordinary bony fishes, as in the common yellow perch for example (*Perca*).

The skeleton of the tail in *Micropterus* is of the typical *homocercal* type, and develops a very completely ossified *urostyle*, directed upward and backward at an angle of about 45 degrees, with a markedly straight vertebral column, as is plainly to be seen in plate 44. The osseous expanded portion of the tail is in the vertical plane, and is thus modified in order to give support to the bony rays of the caudal fin. Possibly

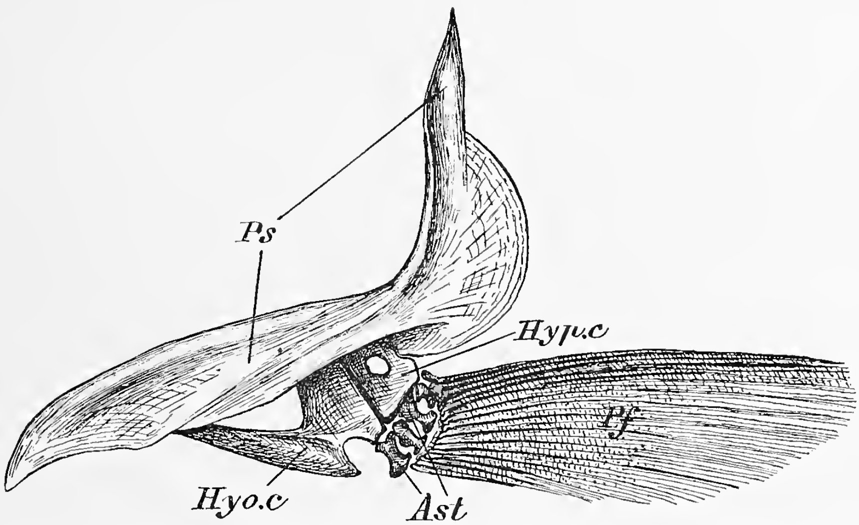


Fig. 8.—Outer aspect of part of shoulder girdle and pectoral fin of *M. salmoides*. Natural size and drawn by the author from his own dissections. *Ps.*, proscapular, with other lettering the same as in fig. 6.

I may formerly have considered that this expanded portion contained *two vertebræ*, and it may. In this case the count for *thirty-two* vertebræ in the column would be correct; but in the reckoning given above this part is omitted and only the vertebræ taken into consideration which possess the true form of those bones.

These terminal modified vertebræ are known as the *hypural plates*, and they are very broad and perfect in *M. salmoides*. The caudal osseous fin-rays are ligamentously attached to the posterior margins of the hypural plates in the simple manner seen among all ordinary teleostean fishes generally. Both above and below, the 29th and 30th vertebræ have narrow and elongated hypural plates springing from them, and the 29th has the hæmal and neural spines in addition thereto, but these last are absent in the 30th vertebra. These hypural spines support distally the outer and very rudimentary fin-rays of the tail. Counting from before backward, it is the third hypural plate upon either side that developed the *urostyle* spoken of above, and which

seems designed to afford additional surface and leverage for the origin of the muscle that controls the movements of the caudal fin or tail.

This is all that need be said in the present paper in regard to the osteology of *Micropterus*. My object in writing this contribution has been to collect together the scattered accounts of the various parts of the skeleton previously given by me in different publications, and to review and correct any errors that may have crept into my previous work upon this form. The paper, it is hoped, will prove useful in connection with a general study of the comparative osteology of the entire family of the *Centrarchidæ*, which some day may be either undertaken by myself or some other anatomist. That such a research should be made and published no one has any doubt.

Doctors Jordan and Evermann, in their Fishes of North and Middle America (Part 1, pp. 984–1012), have treated quite fully of the species and genera of this group, and have given us a very useful classification of them. Nevertheless we stand much in need of full and comparative accounts of the skeletons of *Pomoxis*, *Centrarchus*, *Acantharchus*, *Ambloplites* and other genera, and especially of the sun-fishes, *Apomotis*, *Lepomis*, and *Eupomotis*. When such comparative osteological studies come to be made, and comparisons made with the skeleton in the *Serranidæ* and other families, it is believed that the present contribution to the subject, taken in connection with the figures and text matter of the memoir on *Amia*, will prove to be more or less useful.

Contributions from the Biological Laboratory of the U. S. Fish Commission, Woods Hole, Massachusetts.

THE CHEMICAL COMPOSITION OF THE SUB-DERMAL CONNECTIVE TISSUE OF THE OCEAN SUN-FISH.

By ERIK H. GREEN, A. M.

The tissue under examination was obtained from a sun-fish * taken near the laboratory of the United States Fish Commission at Woods Hole, and at the time the study was undertaken had been preserved in alcohol for nearly a year. The preserved fragments were of a creamy white color, homogeneous, very tough and inelastic, and under the microscope were found to consist almost entirely of elastic-like fibers. As no reference to the chemical composition of this substance could be found, the following analyses were undertaken to determine (1) whether the tissue was composed wholly of elastin, and (2) what was the essential constituent if the tissue was found not to be composed of elastin.

The analyses were conducted as follows: A few grams of the alcoholic tissue were cut into small fragments, rinsed in water, and dried at 110° C. When dry the fragments were of yellow color, semitransparent, hard, and brittle. They were insoluble in hot or cold 10 per cent sodium carbonate, but cold 50 per cent acetic acid caused them to swell enormously, although they did not dissolve. The dry fragments were soluble in strong potassic hydrate, in hot 1 per cent potassic hydrate after one hour, in cold 7 per cent potassic hydrate after two hours, and in the hot 7 per cent potassic hydrate were dissolved in a few minutes. Deflagrated with soda and niter they showed the presence of sulphur and of a trace of phosphorus.

The alcoholic tissue was insoluble in ammonia (sp. gr. 0.955), in lime water, in cold 1 per cent hydrochloric acid, and in hot or cold 10 per cent sodium carbonate. It was slowly soluble in boiling water, cold 10 per cent hydrochloric acid, cold 1 per cent potassic hydrate, and glacial acetic acid. It was readily soluble in strong hot hydrochloric acid, and nitric acid, in cold potassic hydrate (14 per cent), and in hot 5 per cent potassic hydrate.

A characteristic of collogen is its property of gelatinization. To test this property in the tissue under examination, the following experiments were made: About 50

* The sun-fish, *Mola mola* (Linnæus), is found on the Atlantic coast, in summer as far north as the Newfoundland Banks. It occurs in such numbers that ten or more may be seen in a single day, the large black dorsal fins elevated above the surface of the water betraying the presence of the animals as they drift leisurely along. Their total unfitness for food and their pelagic life have rendered them safe from the persecutions of the fishermen, and not only are they abundant, but the individuals attain to enormous size. Specimens 7 or 8 feet in length weigh several hundred pounds. A very large percentage of the weight of each individual is made up of a firm tissue superficially resembling blubber, but not oleaginous. By the following chemical analyses this tissue, heretofore considered worthless, is shown to yield collogen, an albuminoid, which is the basis of all glues and gelatins. The fish are thus shown to have considerable commercial value.—H. C. BUMPUS.

grams of the finely divided and well-washed tissue were boiled for 6 hours in half a liter of distilled water, the water being renewed as it evaporated. The tissue almost completely dissolved, and the yellowish solution on cooling became somewhat viscid, but it did not gelatinize, even when evaporated to a volume of only 100 c. c. The concentrated solution was diluted and filtered. It was neutral to litmus, was precipitated by phosphotungstic acid, and by phosphomolybdic acid; the precipitates were insoluble on heating, but were soluble in potassic hydrate. When precipitated by Millon's reagent the precipitate was soluble in excess of reagent. When precipitated by tannic acid, by metaphosphoric acid, absolute alcohol, and mercuric chloride in presence of free hydrochloric acid the precipitates were insoluble.

The solution gave no precipitate with acetic acid and potassium ferrocyanide, neutral or basic acetate of lead, alum, cupric sulphate or acetate, ferric chloride, sodium orthophosphate, or mercuric potassium iodide. It was not blackened when boiled with lead acetate and potassic hydrate. It gave a strong biuret reaction, and on boiling did not reduce copper. Hot concentrated sulphuric acid and glacial acetic acid produced no violet coloration. Hot strong nitric acid gave no precipitate or coloration, but subsequent addition of ammonia caused a deep orange tint. Saturated with ammonium sulphate, the solution gave a copious precipitate, which floated on the surface of the liquid, forming a coagulum-like layer. Picric acid in saturated solution produced a light-yellow precipitate, insoluble in excess of the reagent, soluble in hot, insoluble in cold water. On shaking, a stiff coagulum formed above the subnatant clear liquid, so that the test tube could be inverted without loss of its contents.[1]

To a few centimeters of the original solution, several drops of formaldehyde (40 per cent solution in water) were added, and the whole evaporated to dryness. The residue was insoluble in hot or cold water. It had become apparently formogelatin.

The reactions given above show that true proteids, also chondrin, are absent, or present in quantities too small for detection. All the phenomena, especially the peculiar and characteristic reactions given by picric acid, ammonium sulphate, and formaldehyde, point to the presence of gelatin, notwithstanding the fact that the solution did not gelatinize and that the original tissue was soluble in dilute potassic hydrate. Elastin can be present only in traces, if at all, since it is insoluble in boiling water, even after 96 hours' boiling,[2] and insoluble also in 1 per cent potassic hydrate,[3] which dissolves the tissue under consideration.

The following experiments were made to determine whether other substances were present with the collogen-like albuminoid.

Several grams of the alcoholic tissue were cut up, washed, and treated with cold 5 per cent potassic hydrate. After 24 hours the tissue was almost wholly dissolved; the solution was filtered, slightly acidified with acetic acid, and submitted to the following reactions. Phosphotungstic acid gave a precipitate soluble on heating, and phosphomolybdic acid, tannic acid, and metaphosphoric acid also gave precipitates. The solution was not precipitated by acetic acid and potassium ferrocyanide, nitric acid, basic or neutral lead acetate, or copper sulphate, and it gave a strong biuret reaction. There was no coloration with hot sulphuric and glacial acetic acid. The fact that the precipitate given by phosphotungstic acid is soluble by heating shows, according to the researches of Mallet,[4] that true proteid substances can not be present in the

[1] Allen and Tankard's test for gelatin. Allen's Com. Organ. Analysis, vol. IV, 1898, p. 469.
[2] Chittenden and Hart. Zeit. für Biologie, 7 Bd., s. 369—(abs.—Horbaczewski Zeit. für Phys. Chemie, Bd. 6, s. 330.)
[3] Ibid.
[4] U. S. Dept. Agric., Division of Chem., Bull. 54, 1898, pp. 20–21.

solution; for proteid substances, including gelatin and chondrin and excepting peptones, give precipitates insoluble on heating. In testing the boiling-water solution of the tissue as given before, the phosphotungstic acid precipitate was found to be insoluble on heating.

The behavior of the substance with digestive fluids was as follows: (A) Fragments of the tissue were rapidly digested at 40° C., when treated with a pepsin hydrochloric acid solution. (B) When treated with an alkaline trypsin solution, the fragments were attacked with extreme slowness. For this experiment about 40 grams of the alcoholic tissue were cut up fine, well washed to remove excess of alcohol, and then treated with a 0.5 per cent sodium carbonate solution of pancreatin, to which a few fragments of thymol were added. The temperature was kept at or near 40° C. After four days the tissue had been only slightly attacked, but at the end of eight days it was almost completely dissolved. When boiled in water (for 10 minutes) and then subjected to the action of the trypsin solution, the fragments were dissolved almost completely in 24 hours. The same result was obtained by first swelling the washed tissue fragments in dilute acetic acid and then submitting them to digestion. The behavior of the subdermal connective tissue toward digestive fluids seems to identify it with collogen, the basis of bone, cartilage, and other gelatine-yielding substances of the body. True collogens are wholly unaffected by tryptic digestion, unless they have been heated previously with water or swelled with acids.[1]

QUANTITATIVE ANALYSIS.

A preliminary analysis was made to determine the percentage of nitrogen, sulphur, and ash in the dried alcoholic tissue. No attempt was made to estimate the amount of phosphorus, since the qualitative examination showed only mere traces of this element. In this, as in the following analysis, the nitrogen was determined by the Gunning modification of the Kjeldahl method, using mercuric oxide as an oxidizing agent, and cochineal as an indicator in the back-titration. Sulphur was estimated as barium sulphate in the usual way, after fusion of the tissue with sodium carbonate and potassium nitrate. Carbon and hydrogen were determined as usual by combustion with cupric oxide, a zone of lead chromate being placed after the oxide to arrest any sulphur dioxide present.

About 50 grams of the alcoholic tissue were cut up, dried for several days at 90° C., pulverized and redried at 110° C., to constant weight. Analysis of this dry substance gave the following results:

Quantity of substance (grams).	Constituents.					
	Ash.		Nitrogen.		Sulphate of barium.	
	Grams.	Per cent.	Grams.	Per cent.	Grams.	Per cent of sulphur.
1.5040	.0221	1.47				
.8162			.1337	16.37		
.2829			.04746	16.77		
.2414			.04032	16.70		
.2065			.03458	16.71		
.6498					.0245	.53
.6836					.0206	.42
Mean.		1.47		16.64		.47

[1] Hoppe-Seyler.—Handbuch d. Phys. u. Path. Chem. Analyse, 6 Auf., s. 270.

These results shed no light on the proteid composition of the tissue, except that the percentage of nitrogen corresponds almost exactly to that given by Chittenden and Hartwell[1], for the nitrogen in elastin prepared from the neck bands of cattle. This fact has little weight, however, in view of the high percentage of ash present in the tissues under consideration.

About 50 grams of the tissue were reduced to fragments, and washed repeatedly, by decantation, with cold water. The fragments were then washed with 90 per cent alcohol for 24 hours, and allowed to stand under ether, with frequent shaking, for 36 hours. The material was then removed, freed from excess of ether, and dried in the air bath at 110° C., to constant weight. The dry fragments were tough and leathery, and could not be powdered. A portion gave with Millon's reagent a light pinkish color. Analysis of this dried substance gave the following results:

Quantity of substance (grams).	Constituents.							
	Water.		Carbon dioxide.		Nitrogen.		Ash.	
	Grams.	Per cent of hydrogen.	Grams.	Per cent of carbon.	Grams.	Per cent.	Grams.	Per cent.
.3229	.1988	6.84	.5704	48.18	....	....	.0013	.40
.3658	.2227	6.75	.6476	48.28	....	....	....	....
.3381	....	....	....	....	.06146	18.17	....	....
.4695	....	....	....	....	.08568	18.25	....	....
Mean..	....	6.80	....	48.23	....	18.21	....	.40

By difference, oxygen + sulphur = sum of means from 100 = 26.36 per cent.

The high percentage of nitrogen shows at once that the tissue is not composed of elastin. Both the carbon and the nitrogen determinations would indicate that the tissue is a collogenous substance, and under appropriate treatment it has yielded glue of excellent quality.

Brown University, *Providence, Rhode Island.*

[1] Abs.—Allen. Com. Organ. Analysis, vol. IV, 1898. [Appendix.]

THE HYDROIDS OF THE WOODS HOLE REGION.

By C. C. NUTTING,
Professor of Zoology, University of Iowa.

INTRODUCTORY NOTE.

The limits of the "Woods Hole region," in the sense here used, may be roughly defined as follows: Starting with the point of Cape Cod as the northern and eastern limits, following the New England coast to New London, Conn.; thence southward to the end of Long Island; thence southeast to the edge of the Gulf Stream, which is followed until off Cape Cod. These limits embrace, roughly, the area that can be covered by one-day excursions by steamer from the U. S. Fish Commission station at Woods Hole, Massachusetts.

It is the purpose of this pamphlet to furnish collectors and workers in this region with a practical and concise means of identifying the species of hydroids known to occur within the area above described. There are a number of other species that almost certainly occur within the Woods Hole region, but, with one or two exceptions involving species of unusual interest, these will be omitted.

Most of the material studied in connection with this work was secured by the author during three summers spent at the U. S. Fish Commission laboratory at Woods Hole and a month at the laboratory of Dr. Alexander Agassiz, at Newport.

The number of species listed indicates a fairly rich hydroid fauna in the region, the general relation being with the Arctic or rather Holarctic fauna, which explains the large percentage of British forms represented on our Atlantic coasts.

The illustrations are from sketches originally made by the author to illustrate a monograph of the North American hydroids, in course of publication by the United States National Museum. Permission was given by the authorities of that institution to have ink tracings made from these sketches, which have been reduced in size and used in the present work.

In order to secure the brevity necessary for the treatment of the subject in the form of a practical guide to identification, it has been necessary to omit all discussion regarding synonymy. In naming genera and species a conservative course has been followed, although the names in some cases have been changed in what will doubtless appear to be an arbitrary manner. The reasons for these changes are in most cases briefly indicated, but the explanations are not so full as would be deemed requisite in a work of more strictly technical nature.

Under the head of "distribution" localities are given where the species have been found in the Woods Hole region.

Much remains to be done before we can discuss with profit the economic bearings of the subject of this work. It is well known, however, that many fishes feed more or less extensively on hydroids. Dr. Edwin Linton has several times called my attention to the fact that he often finds hydroids in the stomachs of fishes while examining them for parasites. I am inclined to think, however, that hydroids do not constitute a very important item in the dietary of our food-fishes, and am rather of the opinion that the economic importance of hydroids lies in the fact that the presence of these forms in quantities in a given region is of value as an indication of abundance of food for fishes in the shape of small crustaceans. It is known that many kinds of hydroids live very largely on minute crustacea, and it follows that where the hydroids thrive the fishes will also find an abundant food supply, especially in the earlier stages of their development.

The author is indebted to many naturalists for material that he failed to secure himself, and has endeavored to briefly acknowledge these favors in their proper connection in the body of the text.

State University of Iowa, *August 10, 1900.*

Key to the families of Hydroida found in the Woods Hole region.

A. Hydranths and gonophores not provided with special chitinous receptacles.
- *a.* Hydranths with scattered filiform tentacles .... Clavidæ.
- *a'.* Hydranths with a single whorl of filiform tentacles, or two or more closely approximated whorls around base of proboscis which might easily be mistaken for a single whorl.
  - *b.* Proboscis conical.
    - *c.* Colony regularly branched .... Bougainvillidæ.
    - *c'.* Colony not branched.
      - *d.* Hydrorhizæ composed of incrusting, adherent tubules overlaid with a film of cœnosarc. Hydractinidæ.
      - *d'.* Hydrorhizæ not mutually adherent and not overlaid with a layer of cœnosarc .... Podocorynidæ.
  - *b'.* Proboscis trumpet-shaped or hemispherical, the distal portion being the bell of the trumpet or equator of the hemisphere .... Eudendridæ.
- *a''.* Hydranths with more than one whorl of filiform tentacles.
  - *b.* A distinct tube of horny perisarc around the stem.
    - *c.* Distal tentacles in two distinct whorls .... Tubularidæ.
    - *c'.* Distal tentacles not in two distinct whorls .... Hyboconidæ.
  - *b'.* No distinct perisarcal tube; stem conspicuously canaliculated; proboscis large .... Corymorphidæ.
- *a'''.* Hydranths with capitate tentacles only .... Syncorynidæ.
- *a''''.* Hydranths with a basal row of filiform tentacles, and with capitate tentacles on the proboscis .... Pennaridæ.

A'. Hydranths and gonophores provided with special chitinous receptacles. (Hydrothecæ and gonangia.)
- *a.* Hydrothecæ with distinct pedicel, and with a septum partly dividing the hydrothecal cavity from the cavity of the pedicel .... Campanularidæ.
- *a'.* Hydrothecæ with an operculum composed of converging segments .... Campanulinidæ.
- *a''.* Hydrothecæ deep, with pedicels or sessile, and without the septum .... Lafœidæ.
- *a'''.* Hydrothecæ reduced to saucer-shaped hydrophores ornamented with a necklace of bright dots, and much too shallow to accommodate the hydranths .... Halecidæ.
- *a''''.* Hydrothecæ sessile, and adnate by their sides to the branches on which they are placed.
  - *b.* Hydrothecæ arranged on both sides of the branches .... Sertularidæ.
  - *b'.* Hydrothecæ arranged on one side only of the branches .... Plumularidæ.

Suborder GYMNOBLASTEA.

No hydrothecæ nor gonangia.

CLAVIDÆ.

Trophosome.—Hydrocaulus branched, simple, or not evident. Hydranths with elongated terete bodies, upon which the smooth filiform tentacles are scattered, or arranged in an ill-defined spiral.

Gonosome.—Gonophores growing from the hydrorhiza, branches, or body of the hydranths, and not producing free medusae.

Key to genera of Clavidæ found in Woods Hole region.

Colony unbranched. Hydranth stems not inclosed in perisarcal tubes.. *Clava.*
Colony profusely branched.. *Cordylophora.*

CLAVA.

Trophosome.—Hydranths single, with slender basal portions and terete bodies. Filiform tentacles, about 20 to 30 in number, scattered over the body and proboscis.

Gonosome.—Gonophores borne in clusters immediately below the basal tentacles.

Clava leptostyla Agassiz. Fig. 1.

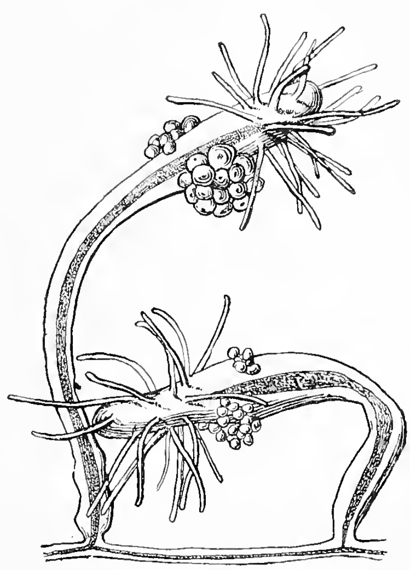
(Contributions to the Natural History of the United States, 1862, IV, p. 218.)

Trophosome.—Hydranths with a slender proximal portion and a long distal proboscis; tentacles more than 20 in full-grown specimens, hydrorhiza forming a closely aggregated meshwork of contiguous tubes.

Gonosome.—Gonophores borne below the proximal tentacles in compact clusters, which may encircle the hydranths or be unsymmetrically collected on one side.

Color.—Brick-red.

Distribution.—Has been found on the rocks near the Hole, where it occurs in patches under the seaweed. I have also found it attached to the piles of the old guano wharf.



1. *Clava leptostyla* Ag.

CORDYLOPHORA.

Trophosome.—Colony regularly branched. Hydranths with scattered filiform tentacles.

Gonosome.—Gonophores borne on the branches, ovate, inclosed in a chitinous investment which resembles a gonangium.

Cordylophora lacustris Allman. Fig. 2.

(Brit. Assoc. Rep., 1843.)

Trophosome.—Colony regularly branched, attaining a height of about three-fourths inch. Main stem not fascicled, straight, giving off alternate branches, which in turn often give off alternate branchlets and pedicels; branches and pedicels often annulated at their origins. Hydranths with fusiform bodies and 16 to 20 scattered filiform tentacles.

Gonosome.—Gonophores ovate, invested in a gonangium-like extension of perisarc, borne on the branches and hydranth pedicels near their bases. Pedicels of gonophores very short and annulated.

Distribution.—Found in a fresh-water pond near the bathing beach at Woods Hole, Mass.

This species is reported from the Woods Hole region just as these pages are going to press. The figure and description are from specimens collected by Prof. A. D. Morrill and kindly forwarded to me by Dr. Charles Hargitt.

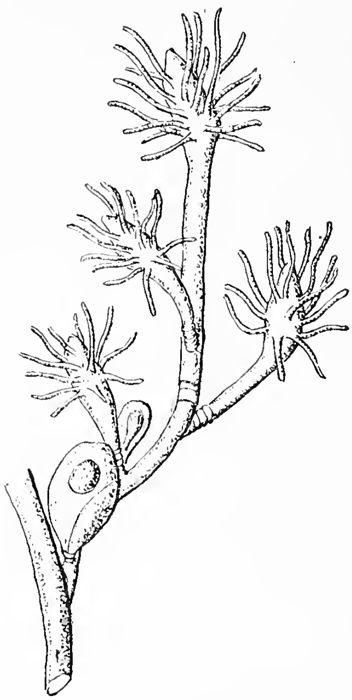
SYNCORYNIDÆ.

Trophosome.—Hydranths with capitate tentacles only, scattered over the elongated body or growing in more or less distinct verticils.

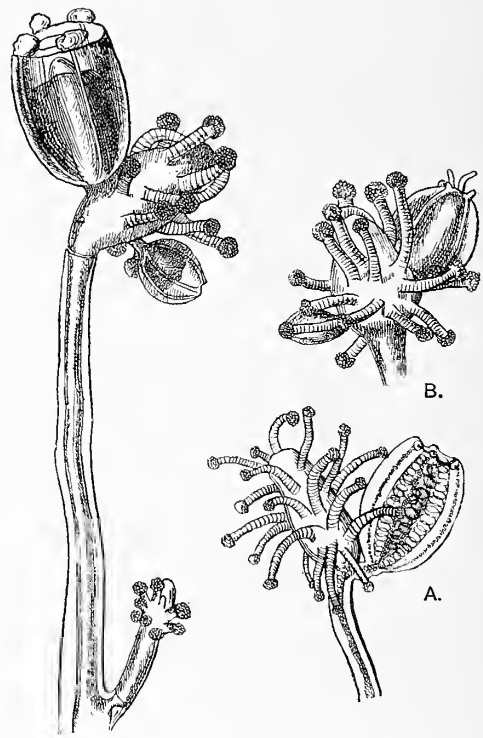
Gonosome.—Gonophores usually borne above the bases of the proximal tentacles, and producing attached or free medusæ with 4 radial canals and 4 tentacles with bulbous bases, and a deep bell.

Key to genera of Syncorynidæ found in the Woods Hole region.

A chitinous perisarc investing the stem. Hydranth body shorter than stem when expanded................*Syncoryne.*
No chitinous perisarc. Hydranths sessile, with long cylindrical bodies..*Corynitis.*



2. *Cordylophora lacustris* Allman.



3. *Syncoryne mirabilis* (Ag.). A. Sessile medusa (♀). B. Sessile medusa (♂).

SYNCORYNE.

Trophosome.—Hydrocaulus well developed, often branched and more or less annulated. Hydranths with numerous stout capitate tentacles and terete bodies.

Gonosome.—Medusæ as described above, bulbous bases of tentacles often with dark eye-spot.

Syncoryne mirabilis (Ag.). Fig. 3..

(*Coryne mirabilis* Agassiz, Cont. Nat. Hist. U. S., IV, p. 185.)

Trophosome.—Colony irregularly branching, without distinct hydrorhiza. Hydranths with terete body and about 16 stout capitate tentacles. Perisarc not annulated.

Gonosome.—Medusæ borne on the hydranth body, with 4 radial canals and 4 marginal tentacles, which are rudimentary and without evident eye-spots in the sessile medusæ, and a very large proboscis on which the sexual elements are produced and cast forth before the medusæ become free. The free medusæ are more hemispherical in shape and have fully developed tentacles with eye-spots on their bases, and the proboscis is much smaller.

Color.—Hydranths rose-red owing to color of lining of body cavity.

Distribution.—Found attached to rocks, seaweed, and floating timbers (A. Agassiz). Specimens were found in both the U. S. Fish Commission and Marine Biological Laboratories, but the labels did not indicate the localities. Waquoit. (Vinal Edwards.)[1]

CORYNITIS.

Trophosome.—No evident perisarc. Colony consisting of single cylindrical hydranths with spirally arranged capitate tentacles.

Gonosome.—Gonophores on hydranth body producing medusæ with two tentacles which bear stalked batteries of nematocysts.

Corynitis agassizii McCrady. Figs. 4 and 79.

(Proceedings Elliott Society, vol. I, No. 1, p. 132.)

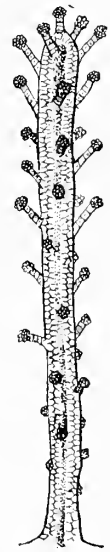
Trophosome.—Colony not branched. Hydranth with a long, cylindrical body and spirally arranged capitate tentacles.

Gonosome.—Gonophores growing low down on the body of the hydranth. Medusæ almost spherical, the surface dotted with clusters of nematocysts. Marginal tentacles 2 or 4, with swollen bases and thickened ends. Ovaries on basal portion of the proboscis. Mouth lobed.

Color.—Medusæ with manubrium, eye-spots and ends of tentacles red. Ovaries orange red.

Distribution.—Found at Woods Hole. (Dr. Murbach.)

I have not seen this species, but Dr. Murbach has kindly allowed tracings to be made from his drawings, to be used in this work.



4. *Corynitis agassizii* McCr. (After Murbach.)

BOUGAINVILLIDÆ.

Trophosome.—Colony branching (in our species) and with a distinct hydrocaulus. Hydranths with a dome-shaped or conical proboscis, and a single whorl of rigid filiform tentacles.

Gonosome.—Gonophores borne on hydrocaulus below the hydranth body. (Never from the hydrorhiza in our species.) Medusa with 4 radial canals. Marginal tentacles either single or in clusters, with sense bodies at their bases.

Key to genera of Bougainvillidæ found in the Woods Hole region.

Hydrocaulus with a strongly marked chitinous perisarc. Medusæ with clustered marginal tentacles and ramified mouth tentacles .... *Bougainvillia.*
Hydrocaulus with a gelatinous perisarc. Medusæ with a single marginal tentacle and no mouth tentacles .. *Perigonimus.*

BOUGAINVILLIA.

Trophosome.—Perisarc strongly marked, branched, and ending below the bases of the tentacles of the hydranths.

Gonosome.—Gonophores borne on pedicels springing from the hydrocaulus. Medusæ with 4 pairs of marginal tentacles when first set free, afterwards with 4 clusters of tentacles, each tentacle with a black eye-spot above its base.

Key to species of Bougainvillia found in the Woods Hole region.

Hydranths with small proboscis and 15 to 20 tentacles. Medusæ with very broad proboscis .... *B. superciliaris.*
Hydranths with conspicuous conical proboscis. Medusæ with a narrow proboscis .... *B. carolinensis.*

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[1] Since the above was written this species has been found in abundance growing on the piles of the U. S. F. C. wharf at Woods Hole.

Bougainvillia superciliaris Ag. Fig. 90.

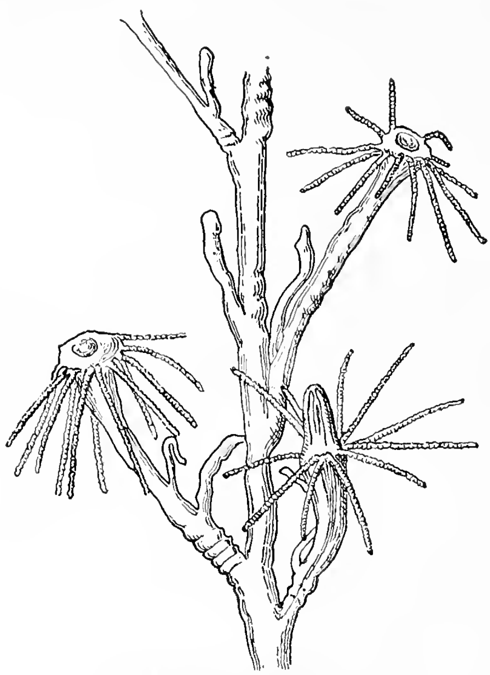
(Cont. Nat. Hist. U. S., IV, p. 289.)

Trophosome.—Colony attaining a height of about 2 inches. Stem not fascicled, irregularly branched, branches and branchlets often annulated proximally. Hydranths with very inconspicuous proboscis and 15 to 20 rigidly disposed tentacles.

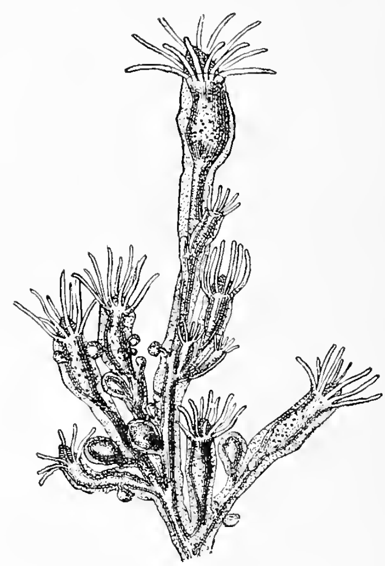
Gonosome.—Gonophores borne mostly on the ultimate branches. Mature medusæ with a very broad and heavy proboscis and much ramified mouth tentacles. Each cluster of marginal tentacles with a large sense-bulb at its base.

Color.—Colony light brown with a greenish tinge. Hydranth body with a suggestion of rose color. Medusæ with a pale-yellow proboscis tinged with red at the end. Sense bodies orange red surrounded with yellow.

Distribution.—Newport, R. I., attached to fucus and shells. Woods Hole. I have not seen the trophosome of this species and have culled the description from that of Dr. Alexander Agassiz. The medusa was taken by me at Woods Hole on August 11, 1899.



5. *Bougainvillia carolinensis* (McCr.)



6. *Perigonimus jonesii* Osborn & Hargitt.

Bougainvillia carolinensis (McCr.). Fig. 5.

(*Hippocrene carolinensis* McCrady. Proc. Elliott Soc., vol. I, No. 1, p. 164.)

Trophosome.—Colony attaining a height of 12 inches, but usually 3 to 6 inches, and branching much as in the preceding species. Hydranths growing on both main stem and branches, with a long, prominent, very flexible proboscis, which may be a lengthened cone, or may be rolled back until it assumes a saucer-like shape; tentacles not more than 12 in specimens examined.

Gonosome.—Gonophores borne on both main stem and branches, often in clusters. Mature medusæ much like the last, but with a short and narrow proboscis.

Color.—Colony light brown with greenish tinge, hydranth body with reddish tinge. Medusæ with brick-red proboscis and sense-bulbs red surrounded by green and yellow. Eye-spots jet black.

Distribution.—Growing on the piles of the U. S. Fish Commission's dock at Woods Hole, and common in the vicinity. It is often found attached to fucus and floating timber.

PERIGONIMUS.

Trophosome.—Colony attaining a height of about 1 inch, either branched or simple; perisarc of a jelly-like consistency and reaching to the bases of the tentacles. Hydranth body terete, the proboscis being large and conical.

Gonosome.—Gonophores borne on the branches or hydranth bodies, in our species. Medusæ bell-shaped, with a simple or lobed proboscis. Marginal tentacles 2 or 4, not in clusters, and with bulbous bases and no eye-spots.

Perigonimus jonesii Osborn & Hargitt. Fig. 6.

(American Naturalist, vol. XXVIII, p. 27.)

Trophosome.—Colony attaining a height of about one-fourth inch, freely branching, the branches erect and continuing insensibly into the hydranth body; gelatinous perisarc very thick and often wrinkled, reaching to the bases of the tentacles and sometimes appearing to include the proximal part of the latter. Hydranths with about 16 tentacles held rigidly, but alternately depressed and elevated; proboscis dome-shaped or subconical.

Gonosome.—Gonophores borne on the hydranth body or branches. Medusæ ovoid, with 2 tentacles, 4 radial canals, and 4 eye-spots; manubrium short with a 4-lobed mouth.

Color.—Colony flesh-colored.

Distribution.—Found on the abdomen and walking legs of *Libinia emarginata.* Collected at Coldspring Harbor, Long Island.

This species does not come strictly within the Woods Hole region, but as it is the only American *Perigonimus* yet described it seemed desirable to include it here.

7. *Eudendrium ramosum* Linn. A. Hydranth bearing female gonophores.

EUDENDRIDÆ.

Trophosome.—Colony branching, often profusely; perisarc evident, often regularly annulated. Hydranths with a single verticil of filiform tentacles, and a proboscis that is at times trumpet-shaped and at times hemispherical, the distal end being the larger.

Gonosome.—Gonophores (male) forming verticils just beneath the tentacles of the hydranth, each verticil being composed of a number of gonophores radiating like the spokes of a wheel, each gonophore having 2 to 4 chambers in linear series; female gonophores not in regular verticils and usually clustered around the hydranth bodies. No medusæ.

EUDENDRIUM.

Characters of the family as given above.

Key to species of Eudendrium found in the Woods Hole region.

A. Main stem fascicled. (Larger species.)
 a. Stem and branches extensively annulated throughout. Hydranth body vasiform .... *E. dispar.*
 a'. Branches and pedicels annulated at proximal ends only.
  b. Colony large, pinnately branched. Male gonophores with 2 or 3 chambers .... *E. ramosum.*
  b'. Colony smaller, less than 3 inches. Male gonophores 4 or 5 chambered and borne on atrophied hydranths .... *E. carneum.*
A'. Main stem not fascicled. (Smaller species.)
 a. Hydranth body globular; pedicels long, slender. Male gonophores 4 or 5 chambered .... *E. tenue.*
 a'. Hydranth body vasiform, colony bushy; pedicels strong, shorter. Female gonophores on aborted hydranths .... *E. capillare.*
 a''. Hydranth body vasiform; colony minute, about one-fourth inch, sparsely branched; pedicels very long, slender and pellucid. Gonophores borne on aborted hydranths .... *E. album.*

Eudendrium ramosum (Linn.). Fig. 7.

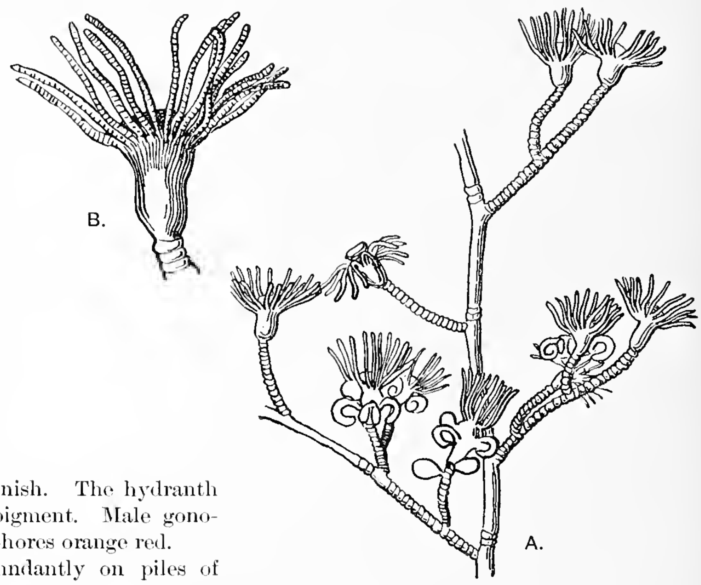
(*Tubularia ramosa* Linn., Syst. Nat., p. 1302.)

Trophosome.—Colony bushy, attaining a height of 6 inches; stem fascicled, the main branches giving off pinnately disposed branchlets; annulations confined to the bases of the internodes and ends of the pedicels. Hydranth body ovoid.

Gonosome.—Male gonophores borne on bodies of hydranths that are not often completely aborted, 2 or 3 chambered; female gonophores borne usually on hydranths below the tentacles, or on the upper part of the pedicels.

Color.—General color greenish. The hydranth bodies lined with vermilion pigment. Male gonophores vermilion; female gonophores orange red.

Distribution.—Growing abundantly on piles of U. S. F. C. wharf at Woods Hole. One of the commonest forms flourishing in shallow water.



8. *Eudendrium dispar* Ag.
B. Hydranth, enlarged.

Eudendrium dispar Ag. Fig. 8.

(Cont. Nat. Hist. U. S., IV, p. 285.)

Trophosome.—Colony large, attaining a height of 5 inches. Stem slender, slightly fascicled, with extensively annulated branches and pedicels. Hydranth body vasiform.

Gonosome.—Gonophores borne on hydranths, which are not aborted and usually not reduced in size.

Color.—General color greenish. Hydranths rose-colored. Male gonophores orange; female gonophores pink.

Distribution.—Found in rather deep, clear water. Naushon (A. Agassiz). U. S. Fish Commission station 7060, off Block Island (Nutting).

Eudendrium carneum Clarke. Fig. 9.

(Mem. Boston Soc. Nat. Hist., III, No. 4, p. 137.)

Trophosome.—Colony attaining a height of about 2 inches; main stem fascicled, pinnately branched, the branches not so widely spreading as in *E. ramosum*. Annulations usually confined to the proximal ends of branches and pedicels, except that the pedicels bearing aborted hydranths and gonophores are deeply ringed throughout. Hydranth body subvasiform.

Gonosome.—Male gonophores 4 or 5 chambered, borne in a verticil around the body of aborted hydranths, which are themselves joined to pedicels bearing ordinary hydranths, the two being thus borne in pairs symmetrically disposed on the branches.

Color.—Hydranth bodies and gonophores bright red.

Distribution.—The specimen described was found in the U. S. Fish Commission collection at Woods Hole. Labeled December 17, 1888.

9. *Eudendrium carneum* Clarke.

10. *Eudendrium tenue* A. Ag.

Eudendrium tenue A. Ag. Fig. 10.

(North American Acalephæ, p. 160.)

Trophosome.—Colony branching irregularly, attaining a height of about one-half inch. Stem not fascicled, loosely branching, the pedicels being long and slender. Hydranth body globular.

Gonosome.—Male gonophores 2 to 4 chambered, borne on unbranched annulated pedicels, the hydranths of which have become aborted. Female gonophores globular, scattered over hydranth body and pedicels. (A. Agassiz.)

Color.—General color bright pinkish. (A. Agassiz.)

Distribution.—Shallow water in Buzzard's Bay. Naushon.

Eudendrium capillare Alder.

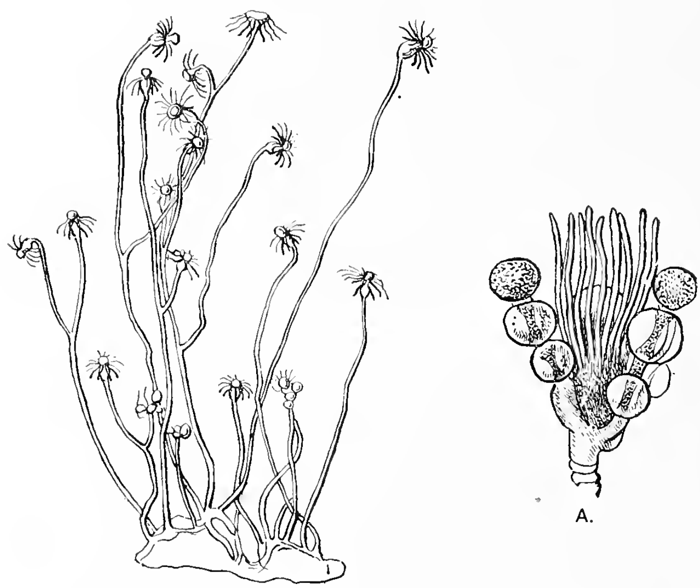
(Catalogue of the Zoophytes of Northumberland and Durham, p. 105.)

Trophosome.—Colony attaining a height of about one-half inch, sparsely branching, the branches and pedicels being sparingly annulated. Hydranth body vasiform.

Gonosome.—Male gonophores 2 or 3 chambered, borne on aborted hydranths springing either from the branches or hydrorhiza. Female gonophores also borne on aborted hydranths.

Color.—Hydranths pale greenish. Male gonophores orange.

Distribution.—Newport, R. I., in shallow water. (C. C. N.)



11. *Eudendrium album* Nutting. A. Hydranth with male gonophores.

Eudendrium album Nutting. Fig. 11.

(Annals and Magazine of Natural History, May, 1898, p. 362.)

Trophosome.—Colony minute, attaining a height of about one-third inch, branching in a straggling manner, the ultimate branches or pedicels being exceedingly long and slender, pellucid, and not decidedly or regularly annulated. Hydranths with vasiform bodies.

Gonosome.—Male gonophores 2 or 3 chambered, borne on hydranths that are generally not aborted, but may be considerably reduced in size. Female gonophores apparently not so numerous as in allied species, borne on partially aborted hydranths.

Color.—General color white, hydranths almost entirely so. Male gonophores pale orange yellow.

Distribution.—Found on floating seaweed secured in taking the tow at Woods Hole; also on U. S. Fish Commission wharf.

HYDRACTINIDÆ.

Trophosome.—Colony formed of "persons" of three sorts springing from an incrusting layer beset with jagged spines. Perisarc not evident. Hydranths with a single whorl of filiform tentacles and a conical proboscis. "Spiral zooids" or defensive persons slender, cylindrical, spirally coiled, with large nematocyst batteries near their distal ends.

Gonosome.—Gonophores fixed sporosacs borne on blastostyles, forming a third or sexual person of the colony.

HYDRACTINIA.

Characters of the family as given above.

Hydractinia polyclina Ag. Fig. 12.

(Cont. Nat. Hist. U. S., IV, p. 227.)

Trophosome.—Colony composed of thickly crowded persons arising from an incrusting plate beset with jagged spines and overlaid with cœnosarc. Hydranths slender, gradually increasing in size from proximal to distal end, tentacles numerous, filiform, arranged in several closely approximated whorls, which are so closely set as to appear as one whorl at the base of the rather low conical proboscis. Spiral zooids generally situated on the borders of the colony and with a number of nematocyst batteries around the distal end.

Gonosome.—Gonophores borne on sexual persons which are much stouter and shorter than the hydranths, and have numerous batteries of nematocysts around the conical proboscis, but no tentacles. No free medusæ.

Color.—Hydranths white, tinged with red. Gonophores, which give the characteristic color to the colony, bright red.

Distribution.—Found growing on gasteropod shells inhabited by hermit crabs, on the bare rock, or on the piles of wharves. The writer has found them among the colonies of *Tubularia crocea* on the U. S. Fish Commission wharf at Woods Hole.

12. *Hydractinia polyclina* Ag. A. Nutritive "person." B. Reproductive persons. C. Spiral zooids or fighting persons.

I have carefully compared this species with *H. echinata* from England, and found that the two are quite distinct, as claimed by Agassiz. Aside from the characters as given by him, I find that the European form has very much larger hydranths than the American and much less numerous tentacles.

PODOCORYNIDÆ (modified).

Trophosome.—Hydranths with a single whorl of filiform tentacles around the base of a conical proboscis. Hydrorhiza a reticulate network of stolons invested with perisarc and usually beset with jagged spines.

Gonosome.—Gonophores growing in a circlet around the basal part of the hydranth body, and producing fixed sporosacs or free medusæ with 4 radiating canals and 4 or 8 marginal tentacles with eye-spots at their bases.

STYLACTIS.

Trophosome.—Hydranths sessile, without evident perisarc, slender, growing from a hydrorhiza composed of a network of anastomosing tubes which are not covered with naked cœnosarc and which usually bear chitinous spines.

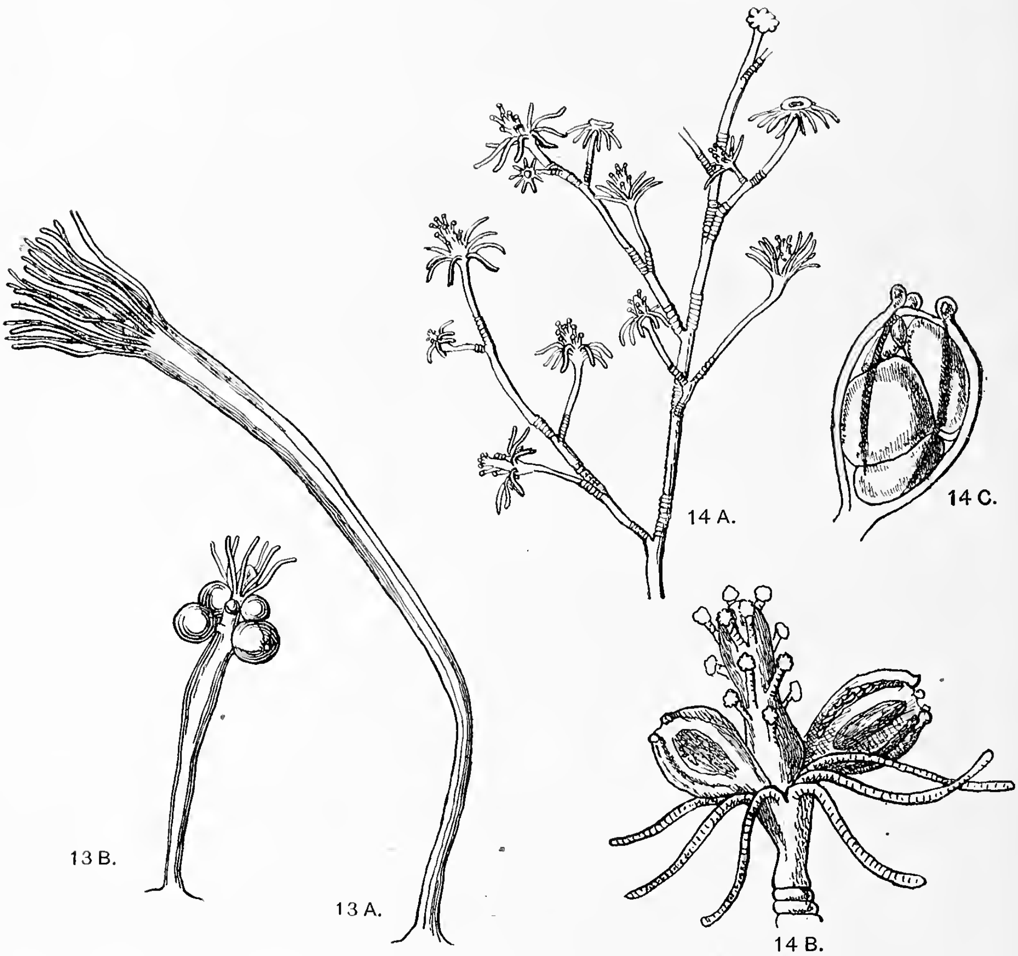
Gonosome.—Sporosacs borne on the hydranth body just below the tentacles and producing medusæ with 8 rudimentary tentacles and no mouth.

Stylactis hooperi Sigerfoos. Figs. 13 and 85.

(American Naturalist, XXXIII, No. 394.)

Trophosome.—Hydranths exceedingly slender and attaining a height when alive of about three-fourths inch. Tentacles in a single whorl, very variable in number, the average, according to Sigerfoos, being 18 to 25. Hydrorhiza covered with a felting of diatoms, etc., but with no covering of naked cœnosarc.

Gonosome.—Gonophores borne on shorter hydranths just below the tentacles and producing free medusæ with 4 radial canals, 8 rudimentary tentacles, and neither mouth nor eye-spots. Ova borne on the very large manubrium.



13. *Stylactis hooperi* Sigerfoos.
A. Nutritive hydranth or "person."
B. Reproductive hydranth or "person."

14. *Pennaria tiarella* McCr.
A. Branch of colony.
B. Hydranth with medusæ (enlarged).
C. Single sessile medusa (enlarged).

Color.—A specimen kept for some time in formalin is of a reddish flesh color. I have not seen the free medusæ, and the color is not given by the original describer.

Distribution.—Found on shells of a living gasteropod, *Ilyanassa obsoleta*. A colony was found at Woods Hole in 1886. Dr. Sigerfoos found numerous specimens at Coldspring Harbor, Long Island.

PENNARIDÆ.

Trophosome.—Colony regularly branched (in our species). Hydranths with a proximal circlet of filiform tentacles and a distal set of spirally arranged or whorled capitate tentacles.

Gonosome.—Gonophores producing medusæ which are either attached permanently or become free when mature, and which have 4 radiating canals and 4 rudimentary tentacles.

PENNARIA.

Trophosome.—Colony pinnately branched, with a pronounced chitinous perisarc. Hydranths with a pyriform body and long mobile proboscis beset with capitate tentacles.

Gonosome.—Gonophores borne above the proximal row of tentacles. Medusæ oblong ovate, with a very large proboscis bearing the sexual products.

Pennaria tiarella McCr. Figs. 14 and 83.

(Proceedings Elliott Soc., vol. I, No. 1, p. 153.)

Trophosome.—Colony attaining a height of about 6 inches, with main stem and branches geniculate and beautifully annulated above origin of each branch, branchlet, and pedicel. Hydranths large, the ones terminating branches being decidedly larger than the others; a basal whorl of about 12 filiform tentacles, and a number of capitate tentacles disposed in indistinct whorls on proboscis.

Gonosome.—Gonophores attached to hydranth body just above whorl of filiform tentacles, and producing oblong-ovate sessile medusæ which sometimes give forth sexual products while still attached, and sometimes become free before giving forth the sexual products.

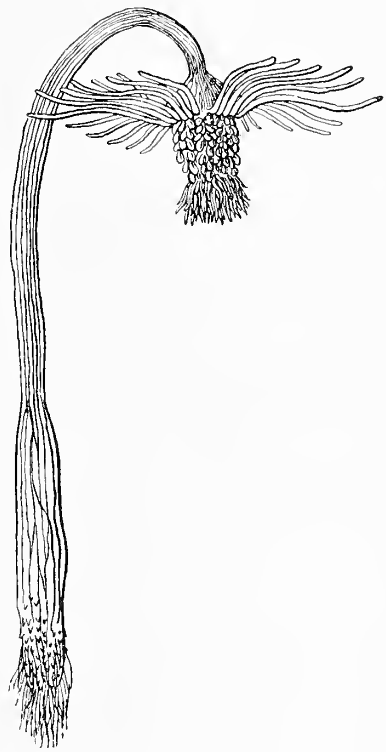
Color.—Stem horn brown with darker areas at the annulations. Hydranth body lined with vermilion, which shows through, producing a beautiful contrast with the white tentacles. Sessile medusæ greenish with vermilion markings.

Distribution.—Abundant on the piles of Fish Commission dock at Woods Hole, and also growing profusely on eelgrass near the Hole. One of the most abundant and beautiful species on our coasts.

CORYMORPHIDÆ.

Trophosome.—Hydranths solitary, without complete tube of perisarc, and having proximal and distal whorls of filiform tentacles and a number of fleshy or tubular processes on the proximal end of the pedicel or stem.

Gonosome.—Gonophores producing medusæ which have 4 radiating canals and 1 to 4 marginal tentacles, of which one is much the largest.



15. *Corymorpha pendula* Ag.

CORYMORPHA.

Trophosome.—Hydranth sharply distinguished from its pedicel and with numerous short filiform tentacles arranged in several closely set whorls around the distal end of the proboscis and a single whorl of larger tentacles around the base of the body.

Gonosome.—Gonophores borne on branched pedicels above the proximal whorl of tentacles and producing fixed or free medusæ with either a single large tentacle or 4 tentacles, one of which is much the largest.

Corymorpha pendula Ag. Fig. 15.

(Cont. Nat. Hist. U. S., IV, p. 276.)

Trophosome.—Hydranths attaining a height of 3 to 4 inches when alive and fully extended. Pedicel with canaliculated cœnosarc, the canals appearing superficially as longitudinal bands which anastomose, especially on the proximal part of the pedicel the distal part of which is abruptly

attenuate and pendant. In place of the hydrorhiza the basal part of the pedicel is frayed out, as it were, into numerous hollow tubular processes.

Gonosome.—Gonophores borne on branched peduncles inserted above the proximal row of tentacles. Medusæ with 1 large tentacle and usually 3 much smaller ones.

Color.—Hydranth body and gonophores bright pink. Medusa with light-yellow proboscis and pink tentacle bulbs.

Distribution.—Sandy and muddy bottoms in rather deep water. The specimens in the U. S. Fish Commission collection at Woods Hole are not labeled, but are said to be from Smith Hole.

TUBULARIDÆ.

Trophosome.—Hydrocaulus with a distinct tubular perisarc, branched irregularly or not at all. Hydranths with a proximal and distal set of filiform tentacles. An adherent, creeping hydrorhiza often produced.

Gonosome.—Gonophores borne above the proximal whorl of tentacles on branched peduncles, and not producing free medusæ. The females produce hydra-like actinules which develop directly into new colonies.

Key to the genera of Tubularidæ found in the Woods Hole region.

Hydranths permanently attached by a regular hydrorhiza .... *Tubularia.*
Hydranths not permanently fixed, the stem or pedicel giving off buds from its free end, which are separated by spontaneous fission and develop into new hydranths .... *Hypolytus.*

TUBULARIA.

Trophosome.—Colony branched or unbranched, attached by permanent chitinous hydrorhiza.

Gonosome.—Gonophores borne in pendent clusters attached by peduncles to the hydranth body above the proximal tentacles. Female gonophores producing actinules.

Key to the species of Tubularia found in the Woods Hole region.

A. Sessile medusæ with distinct radial canals .... *T. couthouyi.*
A′. Sessile medusæ without distinct radial canals and with conical apical processes.
  a. Cœnosarc forming a distinct expansion in the stem just below the hydranth. Perisarc extensively annulated .... *T. larynx.*
  a′. Perisarc not extensively annulated.
    b. Hydranths large. Habitat, shallow water .... *T. spectabilis.*
    b′. Hydranths small. Habitat, deep water .... *T. tenella.*
A″. Sessile medusæ without distinct radial canals and with apical processes of females flattened.
  Hydranths large. Habitat, shallow water .... *T. crocea.*

Tubularia couthouyi Ag. Fig. 16.

(Cont. Nat. Hist. U.S., IV, p. 266.)

Trophosome.—Stems unbranched, often annulated, attaining a height of 5 to 7 inches. Hydranth large, probably the largest on our coasts, often expanding an inch or more; proximal whorl of tentacles 30 to 40 in number; distal set very much smaller and shorter.

Gonosome.—Gonophores growing in dense racemes from the hydranth body just above proximal whorl of tentacles. Sessile medusæ with 4 radial canals and without tentacular processes at the oral end. Females producing actinules.

Color.—Stem and gonophores bright scarlet.

Distribution.—Found in brackish water usually. A number of beautiful specimens were sent me by Dr. Mead, of Brown University, who had them growing in a submerged flatboat at Providence, R. I. A few specimens were taken from a depth of 30 fathoms by the *Fish Hawk* in latitude 40° 49′. 45″, longitude 70° 42′. Mr. George Gray reports them from Quick Hole and off Nobska Point.

Tubularia larynx Ellis & Solander. Fig. 17.

(Nat. Hist. Corallines, p. 30.)

Trophosome.—Colony bushy; stems branched and extensively annulated, attaining a height of 1 to 1½ inches. Cœnosarc of the stem forming a curious collar-like expansion below the hydranth. Hydranth with 16 to 20 proximal tentacles and about the same number in the distal set.

Gonosome.—Gonophores borne in dense clusters, the female without evident radial canals, and with conical tentacular processes at their oral ends.

Color.—Perisarc, in adult specimens, yellow. Body of hydranths and gonophores pinkish scarlet.

Distribution.—Found on rocky and shelly bottoms. A number of specimens secured growing on *Eudendrium dispar* and on seaweed at U. S. Fish Commission station 7060, Muskegat Life-Saving station bearing N. by E. ½ E. 4½ miles. Depth, 5 fathoms.

Tubularia spectabilis (Ag.). Fig. 18.

(*Thamnocnidia spectabilis* Agassiz, Cont. Nat. Hist. U. S., IV, p. 271.)

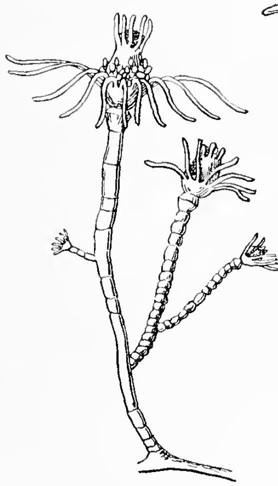
Trophosome.—Colony irregularly branched and sparsely annulated, attaining a height of about 4 inches. Hydranths with about 20 tentacles in the proximal row and nearly the same number in the distal row.

Gonosome.—As in the last species, except that the clusters of gonophores are larger and longer.

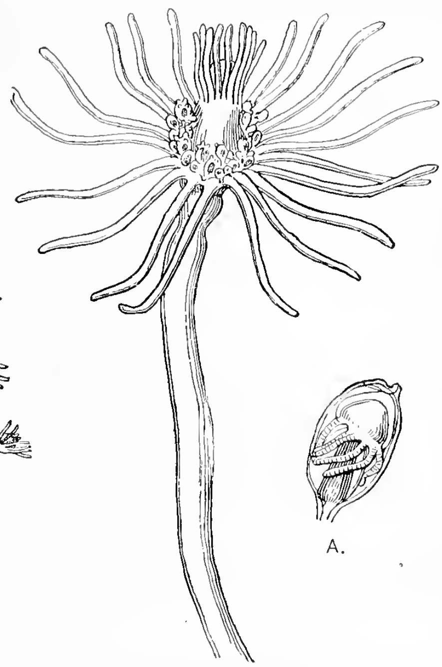
Color.—The stems are very pale; almost white. Hydranth body and gonophores rose red.

Distribution.—Found on rocks at end of Newport Island. At Woods Hole, locality not given.

16. *Tubularia couthouyi.*
A. Sessile medusa.



17. *Tubularia larynx* Ell. & Sol.



18. *Tubularia spectabilis* (Ag.).
A. Gonophore containing an actinule.

Tubularia tenella (Ag.).

(*Thamnocnidia tenella* Ag., Cont. Nat. Hist. U. S., IV, p. 275.)

Trophosome—Colony very small for this genus, hardly exceeding 1 inch in height. Stems loosely branching, not distinctly annulated. Hydranths with a proximal row of about 18 tentacles and about the same number in the distal row.

Gonosome.—As in the last species.

Color.—Stem pale, almost white. Hydranth bodies and gonophores pink.

Distribution.—The open ocean in rocky pools (A. Agassiz). Vineyard Sound, 6 to 10 fathoms. (A. E. Verrill.)

The best distinguishing mark of this species seems to be its small size, only about half that of *T. spectabilis.*

Tubularia crocea (Ag.). Fig. 19.

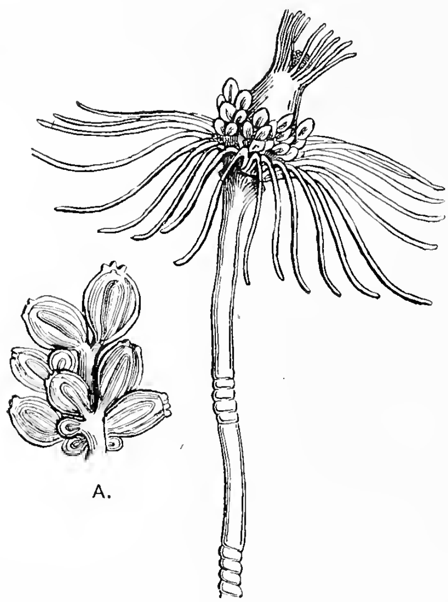
(*Parypha crocea* Ag., Cont. Nat. Hist. U. S., vol. IV, p. 249.)

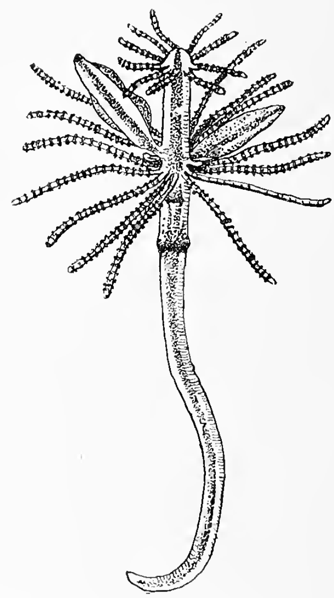
Trophosome.—Colony growing in dense tufts of stems entangled below and separated into long pedicels above, attaining a height of 3 to 4 inches. Stems unbranched or sparsely branched, annulated slightly at intervals and swollen just below the hydranth. Hydranth with a body whorl of about 20 to 24 tentacles and about the same number in the distal set.

Gonosome.—Gonophores growing in racemes or clusters. Sessile medusæ with a group of about four tentacular processes at its oral end, those of the female being laterally compressed. There are no evident radiating canals.

Color.—Body of hydranths and gonophores rose red. Stems pale, almost white.

Distribution.—Found growing very profusely on the piles of the Fish Commission dock at Woods Hole; also on the piles of the docks at New Haven and other similar places.





19. *Tubularia crocea* (Ag.). A. Cluster of gonophores. 20. *Hypolytus peregrinus* Murb. (After Murbach.)

This species is exceedingly difficult to distinguish from *T. spectabilis*. Indeed, little confidence can be placed in identification of specimens without mature female gonophores.

HYPOLYTUS.

Trophosome.—Colony consisting of single hydranths with a long proboscis and a distal and proximal whorl of filiform tentacles. The proximal end of the stem is free.

Gonosome.—Gonophores borne on the proboscis immediately above the proximal whorl of tentacles. They occur singly and not in clusters in the type specimen. The sessile medusæ are long and terete in form and show no tentacular processes.

Hypolytus peregrinus Murbach. Fig. 20.

(Quart. Journ. Mic. Sci., vol. 42, part 3, p. 341.)

The generic description above is sufficient to identify the one known species of the genus.

Description condensed from original. The figure has been copied from that of Dr. Murbach, with his permission.

Distribution.—Woods Hole, Mass.

HYBOCONIDÆ.

Trophosome.—Colony unbranched. Stem with a distinct chitinous perisarc, and rooted to a true hydrorhiza. Hydranths large, with a proximal and distal set of filiform tentacles.

Gonosome.—Gonophores producing free medusæ.

HYBOCODON.

Trophosome.—Stem with distinct, deeply annulated expansion just below hydranth. Hydranth with a proximal whorl and two distinct but closely approximated distal whorls of filiform tentacles.

Gonosome.—Gonophores attached directly to the hydranth body without the intervention of peduncles and developing into free medusæ, each of which has a single large tentacle bearing succeeding generations of medusæ. The medusa are deeply campanulate, with 4 radial canals and a short proboscis.

Hybocodon prolifer Ag. Fig. 76.

(Cont. Nat. Hist. U. S., IV, p. 243.)

Trophosome.—Hydrocaulus unbranched, longitudinally striped owing to the cœnosarcal canals showing through; perisarc suddenly enlarging near the hydranth, where a number of collar-like swollen rings appear, the uppermost being the largest. Hydranth much like that of *Tubularia*, but with two distinctly separated whorls of tentacles around the proboscis, each whorl being composed of about 16 tentacles, the lower being twice as long as the upper.

Gonosome.—Gonophores adnate to the hydranth body just above the basal whorl of tentacles, producing free medusæ with four radial canals and five superficial meridional orange-colored bands when fully mature. The single tentacle is greatly enlarged and near its base a number of medusæ in various stages of development are attached, and these again may in the same manner bear still other groups of medusæ.

Color.—The pigmentation of both hydranth and medusa is orange red.

Distribution.—Deep pools of sea water (Agassiz). The medusa only has been taken at Woods Hole, being collected in the tow net by Mr. Vinal Edwards on March 2. At that time the orange bands were not conspicuous.

Suborder CALYPTEROBLASTEA.

Hydrothecæ and gonangia present.

CAMPANULARIDÆ.

Trophosome.—Hydrothecæ well developed, nonoperculate, either with distinct pedicels or nearly sessile, but not adnate to or partly immersed in stem or branches. Hydrothecal cavity distinctly differentiated from cavity of stem by a septum perforated to allow a cœnosarcal connection between hydranth and pedicel. Hydranth with a trumpet-shaped or subglobular proboscis.

Gonosome.—Gonophores either developing the generative products directly or producing medusæ which usually have otocysts and in which the ovaries are situated along the course of the radial canals and sometimes on the proboscis also, but never on the proboscis alone.

Key to genera of Campanularidæ found in the Woods Hole region.

A. Stem not regularly branched.
- *a.* Hydrothecæ on long pedicels.
  - *b.* Free medusæ with four marginal tentacles at birth .... *Clytia.*
  - *b′.* No medusæ. Reproduction by planulæ .... *Campanularia.*
- *a′.* Hydrothecæ tubular. Pedicels short. Margin of hydrothecæ entire, not toothed .... *Hebella.*

A′. Stem regularly branched.
- *a.* Free medusæ with 16 or more marginal tentacles. Lithocysts on the bases of tentacles .... *Obelia.*
- *a′.* No free medusæ, the mature gonangia bearing medusa-like bodies on their summits .... *Gonothyræa.*
- *a″.* No free medusæ, the planulæ being developed within the gonangium .... *Campanularia.*

The *Campanularidæ* offer great difficulties in identification, owing to the necessity of basing generic characters on the gonosome and the practical identity of the trophosomes of different genera. The following entirely artificial key, although inadequate in some cases, is presented to aid the collector and student in the identification of specimens without the gonosome.

Key for identification of Campanularidæ found in Woods Hole region (based on trophosome alone).

- A. Stem neither regularly branched nor fascicled. This includes cases where a pedicel supports other pedicels springing from it in an irregular manner.
  - a. Pedicels strongly annulated throughout.
    - b. Hydrothecal margin not toothed, but entire .... *Campanularia poterium.*
    - b′. Hydrothecal margin evidently toothed.
      - c. Hydrothecæ small, tubular. Teeth very shallow .... *Clytia volubilis.*
      - c′. Teeth sharp, deeply cut. Hydrothecæ small, with a tendency to irregular branching .. *Campanularia minuta.*
  - a′. Pedicels not strongly annulated except at ends.
    - b. Hydrothecal teeth squared off at ends. Hydrothecæ ornamented with vertical lines ... *Campanularia hincksii.*
    - b′. Hydrothecal teeth evenly rounded. Hydrothecæ very large, with parallel sides and exceedingly thin walls .... *Clytia grayi.*
    - b″. Hydrothecal teeth sharply pointed, the extreme tips sometimes rounded.
      - c. Pedicels usually more than three times the length of hydrothecæ. Hydrothecæ deeply campanulate .... *Clytia bicophora.*
      - c′. Pedicels seldom more than three times the length of hydrothecæ.
        - d. Hydrothecæ broad, often subtriangular in outline .... *Clytia noliformis.*
        - d′. Hydrothecæ deep, cylindrical .... *Clytia cylindrica.*
- A′. Stem regularly branched.
  - a. Stem fascicled.
    - b. Hydrothecæ with pointed or regularly rounded teeth. Pedicels arranged in verticils around stem .... *Campanularia verticillata.*
    - b′. Hydrothecæ with very shallow, evenly rounded teeth. Colony with subverticillate branches .. *Obelia longissima.*
    - b″. Hydrothecæ with square, or bimucronate teeth.
      - c. Hydrothecæ ornamented with vertical lines or longitudinal ridges.
        - d. Hydrothecæ very deep, tubular. Pedicels with more than 6 annulations .... *Obelia bicuspidata.*
        - d′. Hydrothecæ not so deep. Pedicels with usually 3 to 6 annulations .... *Obelia bidentata.*
      - c′. Hydrothecæ without evident longitudinal lines .... *Obelia gelatinosa.*
  - a′. Stem not regularly fascicled.[1]
    - b. Hydrothecal margin toothed.
      - c. Pedicels usually in pairs or subopposite .... *Campanularia edwardsi.*
      - c′. Pedicels regularly alternate.
        - d. Pedicels longer than hydrothecæ, not completely annulated .... *Campanularia neglecta.*
        - d′. Pedicels shorter than hydrothecæ.
          - e. Aperture of hydrothecæ broader than middle part .... *Gonothyræa tenuis.*
          - e′. Aperture scarcely broader than middle part .... *Gonothyræa loveni.*
    - b′. Hydrothecal margin even, not toothed.
      - c. Colony with a very slender central stem from which much-branched, short, lateral branches arise in a verticillate manner.
        - d. Hydrothecæ triangular in outline. Pedicels usually with 4 to 6 annulations .... *Obelia flabellata.*
        - d′. Hydrothecæ deeper, subtriangular in outline. Pedicels usually with more than 6 annulations .... *Obelia commissuralis.*
        - d″. Hydrothecæ deeply campanulate. Pedicels often considerably longer than hydrothecæ and with their middle portions not annulated .... *Campanularia amphora.*
      - c′[1]. Colony not branched in a regularly verticillate manner.
        - d. Stem nearly straight, branches strong, suberect, and giving off bushy branchlets. Hydrothecæ very deep, campanulate. Pedicels very short .... *Obelia dichotoma.*
        - d′. Stem strongly flexuose, or geniculate, usually not profusely branched, and giving off alternate pedicels.
          - e. Stem flexuose. Hydrothecæ deep, with slightly everted margins. Pedicels sometimes quite long, with middle portions not annulated .... *Campanularia calceolifera.*
          - e′. Stem decidedly flexuose, each pedicel forming a graceful curve continuous with the internode from which it springs. Hydrothecæ campanulate. Pedicels with 6 to 12 annulations .... *Campanularia flexuosa.*
          - e″. Stem geniculate or abruptly bent at the nodes.
            - f. Pedicels long, with many annulations .... *Campanularia angulata.*
            - f′. Pedicels short, borne on broad processes from stem. Hydrothecæ subtriangular. *Obelia geniculata.*
- A″. Colony parasitic, usually growing in a straggling or irregular manner over other hydroids. Hydrothecæ tubular, with even margins. Pedicels very short, sometimes hardly apparent .... (Genus *Hebella.*)
  - a. Hydrothecæ large, curved. Colony almost always found growing symmetrically over *Sertularia cornicina* .... *Hebella calcarata.*
  - a′. Hydrothecæ much smaller. Colony growing in a straggling manner over various hydroids and other organisms .... *Hebella pygmæa.*

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[1] An appearance of fasciculation is often produced when a simple stem is overgrown with parasitic hydroids, or even when young colonies are growing over older ones of the same species.

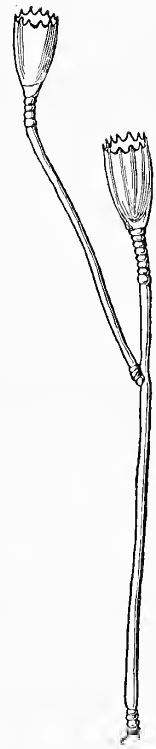
CLYTIA.

Trophosome.—Colony not regularly branched. Hydrothecæ with toothed margins and long pedicels.

Gonosome.—Gonangia containing gonophores which produce medusæ with 4 radial canals, 4 marginal tentacles at birth, and 8 lithocysts between the tentacle bases.

Key to the species of Clytia found in the Woods Hole region.

Hydrothecæ small, bell-shaped, with deeply cut teeth .... *C. bicophora.*
Hydrothecæ small, cylindrical, with sharp teeth and short pedicels............... *C. cylindrica.*
Hydrothecæ larger, stout, broadly campanulate, or subtriangular in outline, with large, evenly rounded teeth.. *C. noliformis.*
Hydrothecæ very large, with parallel sides and evenly rounded teeth.................. *C. grayi.*



21. *Clytia bicophora* Ag.

Clytia bicophora Ag. Fig. 21.

(Cont. Nat. Hist. U. S., IV, p. 304.)

Trophosome.—Stem seldom branching, never regularly so. Hydrothecæ deeply campanulate, with about 14 pointed teeth. Pedicels large, long, annulated at the ends, usually smooth through the middle portion.

Gonosome.—Gonangia deeply and evenly ringed, resembling a Chinese lantern, usually borne on the rootstock, sometimes on the stem. Medusa when liberated hemispherical, with 4 tentacles and 8 lithocysts situated between the bases of the tentacles, and a short manubrium.

Distribution.—Shallow water, attached to shells, other hydroids, seaweed, etc. Found on the stems of *Tubularia crocea* growing on the piles of the U. S. Fish Commission dock at Woods Hole.

Both Hincks and Verrill regard this species as identical with *Clytia johnstoni* Alder, of British waters. I have carefully compared American specimens of *C. bicophora* with specimens of *C. johnstoni* from England, and find that the former is a much more delicate and smaller species, the hydrothecæ of *C. johnstoni* being on the average twice as long and wide as those of *C. bicophora.*

Clytia cylindrica Ag.

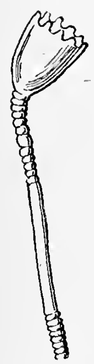
(Cont. Nat. Hist. U. S., IV, p. 306.)

Trophosome.—Stems unbranched, with pedicels shorter than in *C. bicophora*, annulated at the proximal and distal ends. Hydrothecæ cylindrical, small, deep, with about 10 deeply cut, sharply pointed teeth.

Gonosome.—Gonangia slender, oblong, flattened, not annulated, containing developing medusæ which escape singly. Medusæ not described.

Distribution.—Much as in the last species. Found in Buzzards Bay and at Naushon. (A. Agassiz.)

I have not seen this species, and have compiled the above descriptions from the writings of Louis and Alexander Agassiz.



22. *Clytia noliformis* (McCr.)

Clytia noliformis (McCr.). Fig. 22.

(*Campanularia noliformis* McCr., Proc. Elliott Soc., vol. I, No. 1, p. 194.)

Trophosome.—Pedicels short, usually not more than twice as long as the hydrothecæ, strongly annulated, rising from a creeping rootstock. Hydrothecæ broadly campanulate, with 10 to 12 very prominent, deeply cut teeth with rounded points. Texture of hydrothecæ stouter than in other species of the genus.

Gonosome.—My specimens are without gonangia, and I have been unable to find any description of them.

It is not certain that this species occurs in the Woods Hole region. Dr. Agassiz reports it from Buzzards Bay, but as he considers it identical with the *Clytia cylindrica* of his father's work, a species that appears to me to be distinct, I am not sure whether he had McCrady's species or not. My own specimens came from Beaufort, N. C.

Clytia grayi, new species. Fig. 23.

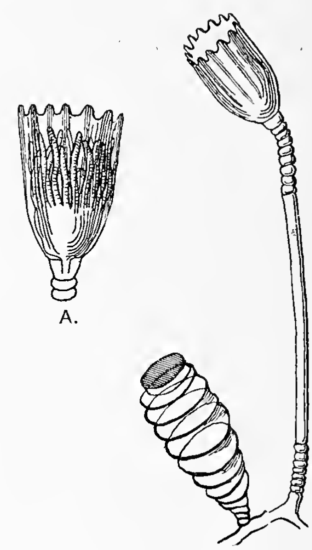
Trophosome.—Stems unbranched or irregularly branched, strongly annulated, except on the middle portion. Hydrothecæ very large (twice as large as in *C. bicophora*), cylindrical, the sides being parallel and bottom hemispherical; marginal teeth about 16 in number, evenly rounded and not very deeply cut. There is often a tendency to a longitudinal plaiting, which shows as short, straight lines running downward from between the teeth. Hydranth with about 20 tentacles.

Gonosome.—Gonangia oblong, conspicuously and regularly annulated, attached to creeping rootstock. Medusæ not known.

Distribution.—Found growing on living worm tubes composed of sand. Dredged by the U. S. Fish Commission steamer *Fish Hawk* at station 7051, latitude, 40° 46′ 30″ N.; longitude, 70° 40′ W. Depth 31 fathoms.

The largest *Clytia* which has up to this time been found in American waters.

Named in honor of Mr. George Gray, of the Marine Biological Laboratory at Woods Hole, a man who has done much for American marine biology.



23. *Clytia grayi* Nutting.
A. Hydrotheca with hydranth (enlarged).

CAMPANULARIA.

Trophosome.[1]—Colony unbranched, regularly branched, or fascicled. Hydrothecæ without operculum and with or without marginal teeth.

Gonosome.—Gonangia producing sexual products which develop into planulæ within the gonangium. No medusæ.

Key to species of Campanularia found in the Woods Hole region.

A. Colony not regularly branched.
- *a.* Hydrothecæ with margin entire .... *C. poterium.*
- *a′.* Hydrothecal margin toothed.
  - *b.* Teeth square or truncated at top .... *C. hincksii.*
  - *b′.* Teeth very shallow, forming sinuosities or undulations around aperture. Hydrothecæ deep, tubular.. *C. volubilis.*
  - *b″.* Teeth very sharp and deeply cut, pedicels long, stem irregularly branched .... *C. minuta.*

A′. Colony regularly branched.
- *a.* Hydrothecal margin toothed.
  - *b.* Teeth castellated or bimucronate .... *C. neglecta.*
  - *b′.* Teeth acute, stem not fascicled .... *C. edwardsi.*
  - *b″.* Teeth sharp or rounded, stem fascicled .... *C. verticillata.*
- *a.* Hydrothecal margin entire.
  - *b.* Branches arranged in subverticillate manner around a slender axial stem. Pedicels often longer than hydrothecæ .... *C. amphora.*
  - *b′.* Branches not arranged in a subverticillate manner. Main stem giving off alternate pedicels.
    - *c.* Stem angulated, or strongly geniculate. Pedicels long .... *C. angulata.*
    - *c′.* Stem flexuose. Pedicels annulated throughout. Gonangia with a large terminal aperture ..... *C. flexuosa.*
    - *c″.* Stem slightly flexuose. Pedicels long, not always annulated throughout. Gonangia with a subterminal aperture .... *C. calceolifera.*

Campanularia poterium (Ag.). Fig. 24.

(*Clytia poterium* Ag., Cont. Nat. Hist. U. S., p. 297.)

Trophosome.—Stem unbranched, the pedicels arising directly from annulated rootstock; pedicels annulate throughout, the annulations often oblique, giving a twisted appearance. Hydrothecæ deeply campanulate; aperture not toothed; basal portion thickened greatly, so as to include what appears to be the uppermost annulation. Hydranths with 24 tentacles.

[1] It appears to be impossible to construct generic characters for the *Campanularidæ* on the basis of the trophosomes. The classification of the group is unnatural and unsatisfactory in the extreme, but this is not the place to attempt its rectification.

Gonosome.—Gonangia rather slender, not decidedly annulated, growing from the rootstock. The sexual products pass through part of their development in an acrocyst resting on top of gonangium.

Distribution.—Found growing on stones, shells, seaweed, etc. A specimen in the U. S. Fish Commission collection is labeled: "Off Nantucket Island. Depth, 23 fathoms."

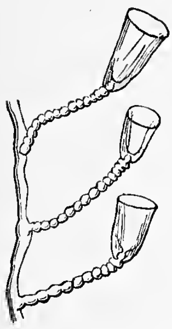
Campanularia hincksii Alder. Fig. 25.

(North. and Durh. Cat. in Trans. Tyneside Field Club, III, p. 127.)

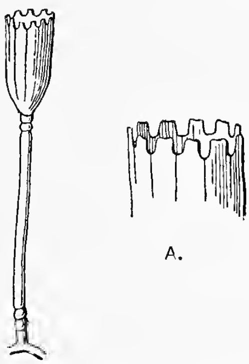
Trophosome.—Pedicels springing directly from a creeping rootstock, not extensively annulated. Hydrothecæ large, deep, cylindrical, with about 12 prominent square-topped teeth, from between which vertical lines pass down over the surface of the hydrotheca.

Gonosome.—Gonangia long, annulated, resembling those of *Clytia johnstoni*, but often not so deeply annulated.

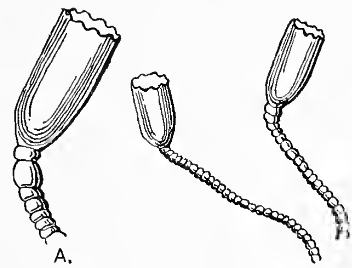
Distribution.—Growing on stones, shells, etc., in rather deep water. A specimen was secured from a depth of 15 fathoms near Newport, R. I. Contrary to the rule among campanularians, the hydranth of this specimen was brilliantly colored, the general color being yellow and the basal part scarlet.



24. *Campanularia poterium* (Ag.)



25. *Campanularia hincksii* Alder.
A. Upper part of hydrotheca (enlarged).



26. *Campanularia volubilis* (Linn.).
A. Hydrotheca (enlarged).

Campanularia volubilis (Linn.). Fig. 26.

(Syst. Nat., p. 1311, under name of *Sertularia volubilis.*)

Trophosome.—Pedicels long, extensively annulated, springing from a creeping rootstock. Hydrothecæ small, tubular, with about 10 shallow rounded marginal teeth.

Gonosome.—Gonagia borne on the rootstock, flask-shaped, with a long tubular neck and small terminal aperture.

Distribution.—Found growing on *Sertularella tricuspidata* on specimens in the U. S. Fish Commission collection; supposed to be from rather deep water.

The combination of tubular hydrothecæ with very shallow teeth and extensively annulated pedicels will differentiate this form from others on the North Atlantic coast.

Campanularia minuta, new species. Fig. 27.

Trophosome.—Stem branching in an irregular straggling manner, attaining a height of about one-fourth inch. Pedicels long, extensively annulated, rising almost parallel with the main stem, which is itself extensively annulated, although there are smooth portions of considerable extent. Hydrothecæ very small, deeply campanulate, with 8 to 10 very acute and prominent teeth.

Gonosome—Not known.

Distribution.—Parasitic on *Obelia commissuralis* from the piles of the wharf at New Bedford. Collected by Mr. Vinal Edwards.

This species appears to be quite distinct. It seems to be nearest to *C. raridentata* Alder, from which it differs in being branched, in the extent of annulations of the pedicels, and in the hydrothecæ being considerably broader in proportion to their length.

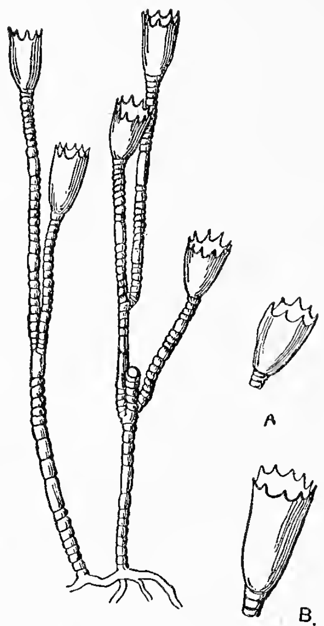
Campanularia edwardsi, new species. Fig. 28.

Trophosome.—Colony attaining a height of over an inch, branching somewhat irregularly, but with a distinct tendency to send off pedicels from the main stem in subopposite pairs. Stems, branches, and pedicels exceedingly long and slender, with the annulations confined to the proximal portions, except a few just below the hydrothecæ. Hydrothecæ very large, deeply campanulate, with 12 to 14 exceedingly sharp, slender teeth, more acuminate than in any other species in the region. Hydranth with about 28 tentacles.

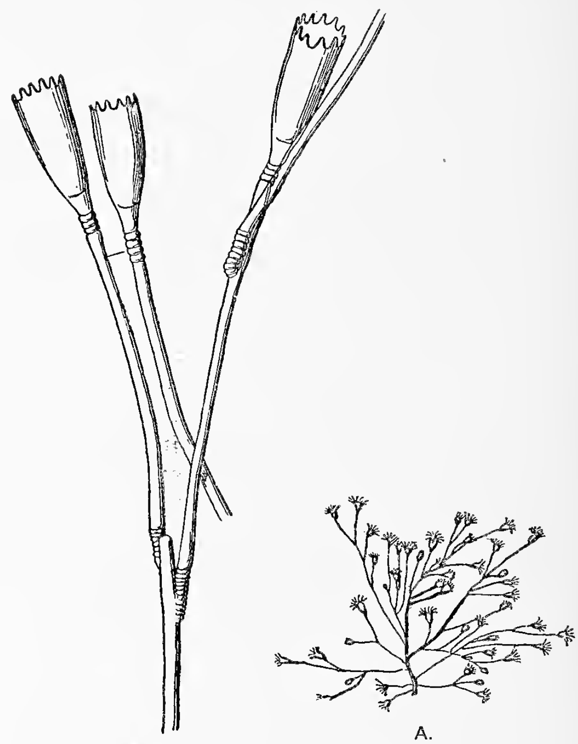
Gonosome.—Unknown.

Distribution.—The type specimen was found on the piles of the U. S. F. C. dock at Woods Hole. This is one of the most distinct and beautiful of the American campanularians.

Named for Mr. Vinal Edwards, the veteran collector at the U. S. F. C. station at Woods Hole.



27. *Campanularia minuta* Nutting. A. and B. Hydrothecæ (enlarged).



28. *Campanularia edwardsi* Nutting. A. Colony, natural size.

Campanularia neglecta (Alder.). Fig. 29.

(*Laomedea neglecta* Alder, North. and Durham Cat. in Trans. Tyneside Field Club, p. 123.)

Trophosome.—Colony branching, main stem flexuose, giving off alternate pedicels which are long, slender, and annulated at the ends. Hydrothecæ deeply campanulate, almost tubular, with their margins armed with 8 to 10 teeth which are bimucronate; that is, the summit of each tooth is crowned with two minute denticles.

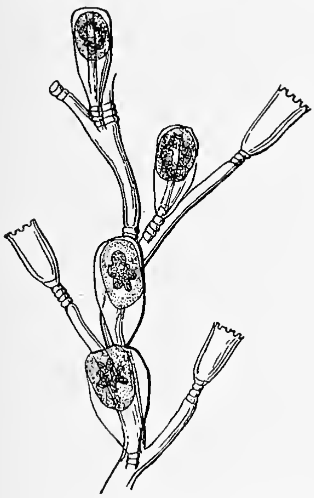
Gonosome.—Gonangia borne in the axils of the pedicels, oblong ovate, smooth, somewhat truncated above. The mature gonangium often has a globular acrocyst on its summit.

Distribution.—In shallow water, on stones, shells, and other hydroids. Reported by Professor Verrill from Casco Bay, Maine. I find it in my notes as occurring at Woods Hole, but fail to find specimens. The figure is from a British specimen.

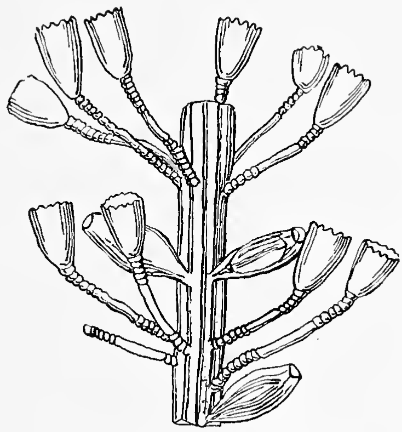
Campanularia verticillata (Linn.). Fig. 30.

(*Sertularia verticillata* Linn., Syst. Nat., p. 1310.)

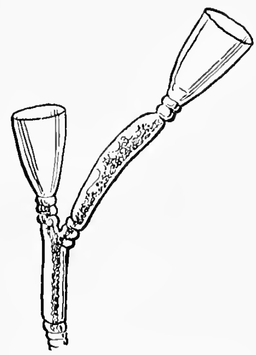
Trophosome.—Colony branched, attaining a height of about 5 inches. Stem and branches fascicled, composed of many parallel tubes from which the pedicels arise in a verticillate manner. Hydrothecæ large, rather broadly campanulate, with about 12 deeply cut acuminate teeth.



29. *Campanularia neglecta* (Alder).



30. *Campanularia verticillata* (Linn.).



31. *Campanularia amphora* (Ag.).

Gonosome.—Gonangia borne on the main stem and branches, oblong flask-shaped, with necks often produced into tubular extensions with terminal openings.

Distribution.—Found in rather deep water attached to stones, shells, etc. Block Island Sound, 17 to 45 fathoms. Fisher Island Sound, 4 to 11 fathoms. (Verrill.)

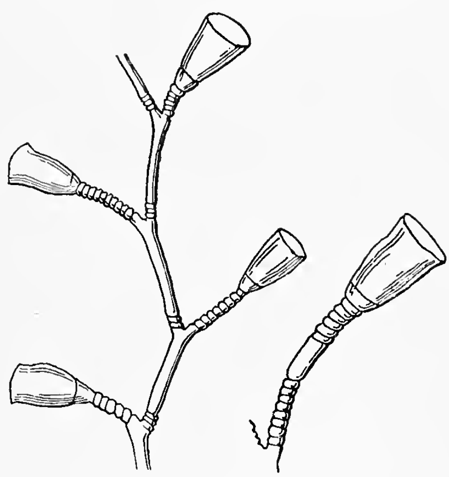
Campanularia amphora (Ag.). Fig. 31.

(*Laomedea amphora* Ag., Cont. Nat. Hist. U. S., IV, p. 311.)

Trophosome.—Colony attaining a height of 6 to 7 inches, branching in a subverticillate manner, the branches inclined upward more than in *Obelia commissuralis*, which it greatly resembles. "But the most marked difference is in the middle of each internode, where it bulges laterally and directly in line with the point of insertion of the branch or pedicel below it." (L. Agassiz). Pedicels annulated. Hydrothecæ deeply campanulate, very gracefully formed, aperture entire, margin slightly everted. Hydranth with about 30 tentacles.

Gonosome.—Female gonangia elongate oval, about four times as long as the hydrotheca, somewhat truncate at top, and with a very small aperture. Male gonangia more slender, with a slightly produced neck.

Distribution.—Common in shallow water in the Woods Hole region. This species is apt to be mistaken for *Obelia commissuralis* when the gonosome is absent.



32. *Campanularia angulata* Hincks.
A. Hydrotheca and pedicel (enlarged).

Campanularia angulata Hincks. Fig. 32.

(Annals and Magazine of Nat. Hist., 3d series, VIII, p. 261.)

Trophosome.—Colony slightly branched, attaining a height of about three-fourths inch. Stem geniculate, with long internodes, annulated above the origin of each pedicel. Pedicels long, usually

annulated throughout. Hydrothecæ rather deeply campanulate, aperture entire. Hydranth with about 24 very slender tentacles.

Gonosome.—Gonangia borne on the rootstock, irregularly ovate, obscurely wrinkled, neck short and broad.

Distribution.—I have several fragmentary specimens from Woods Hole region that agree very closely with Hincks's figures. Comparing these, however, with some of the terminal branches of *C. amphora*, I find them to agree closely with these also. Verrill reports the species from Casco Bay. I do not know whether his material embraced the gonosome or not.

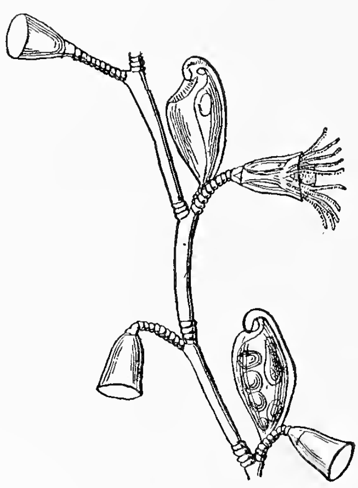
Campanularia calceolifera Hincks. Fig. 33.

(Annals and Magazine of Nat. Hist., 4th series, vol. VIII, p. 78.)

Trophosome.—Colony usually consisting of a single slightly flexuose stem, but sometimes it gives off long branches similar in every way to the main stem, which sends off alternate pedicels of varying length, but usually fully annulated and considerably shorter than the hydrothecæ. Hydrothecæ without teeth, deeply campanulate, and with gracefully everted margins.

Gonosome.—Gonangia of peculiar shape, tapering basally, with latero-terminal aperture from which a short, curved tube projects into the gonangial cavity.

Distribution.—In shallow water on stones, seaweed, submerged timbers, etc. Noank, Conn., on bottom of boat (Clarke). Woods Hole, on piles of U. S. Fish Commission's dock.



33. *Campanularia calceolifera* Hincks.

34. *Campanularia flexuosa* (Hincks). A. Gonangium with escaping planula.

This beautiful species can be immediately identified when sexually mature. Otherwise the best character is the elegant shape of the hydrothecæ.

Campanularia flexuosa (Hincks). Fig. 34.

(Annals and Magazine of Nat. Hist., 3d series, vol. VIII, p. 260. Under name of *Laomedea flexuosa*.)

Trophosome.—Colony usually in the form of a single flexuose stem giving off a series of regularly alternating pedicels. Stem with three or four well-marked annulations above the origin of each pedicel; pedicels apparently continuous with the internodes from which they spring, and with which they curve continuously, rather large, completely annulated and diminishing gradually in size toward the distal end. Hydrothecæ campanulate, not very deep, with even rims. Hydranths with a web between the bases of the tentacles.

Gonosome.—Female gonangia very large and abruptly truncated above; male gonangia much smaller and more oval, but with no neck; sexual products forming planulæ before leaving gonangia.

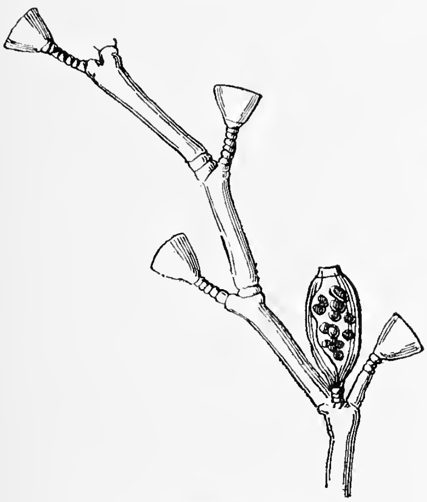
Distribution.—Very abundant on floating seaweed and on rocks and timbers in shallow water. One of the most abundant species at Woods Hole.

OBELIA.

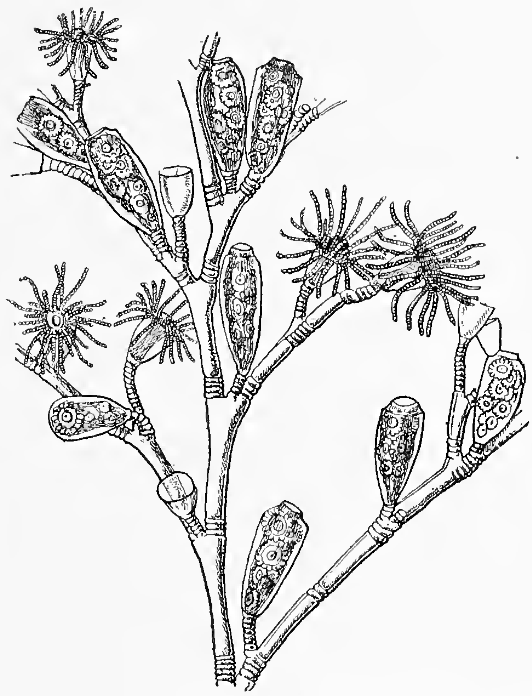
Trophosome.—Colony branched, stem simple or fascicled. Hydrothecæ campanulate, margin even, or toothed.

Gonosome.—Gonangia borne in axils of pedicels, usually oblong ovate, with terminal aperture usually surrounded with a collar or short neck. Medusæ with disk-shaped umbrella, 4 radial canals, more than 8 marginal tentacles, 8 lithocysts borne on bases of tentacles, and a short manubrium without mouth tentacles.

It is apparently impossible to define this genus so that it can be distinguished from *Campanularia* by the trophosome alone.



35. *Obelia flabellata* Hincks.



36. *Obelia commissuralis* McCr.

Key to the species of Obelia found in the Woods Hole region.

(A very careful manipulation of the microscope is often necessary before the characters of the hydrothecal margin can be definitely determined.)

A. Hydrothecal margin entire. Stem not fascicled.
- *a.* Colony a long central stem, giving off subverticillate branches which are themselves palmately branched.
  - *b.* Hydrothecæ triangular. Pedicels usually with more than 6 annulations.......... *O. flabellata.*
  - *b′.* Hydrothecæ deeper, subtriangular. Pedicels often with more than 6 annulations.......... *O. commissuralis.*
- *a′.* Colony irregularly branched; branches erect, often themselves branched. Hydrothecæ large, very deeply campanulate.......... *O. dichotoma.*
- *a″.* Colony usually consisting of a single geniculate stem, giving off alternate pedicels which are supported on broad shoulders of the internodes from which they spring.......... *O. geniculata.*

A′. Hydrothecal margin toothed. Stem fascicled.
- *a.* Teeth bimucronate, or castellated.
  - *b.* Hydrothecæ triangular, without vertical lines.......... *O. gelatinosa.*
  - *b′.* Hydrothecæ deep, ornamented with vertical lines.
    - *c.* Hydrothecæ deeply tubular. Pedicels with 6 to 15 annulations.......... *O. bicuspidata.*
    - *c′.* Hydrothecæ shorter. Pedicels with 3 to 6 annulations.......... *O. bidentata.*
- *a′.* Teeth forming a series of exceedingly shallow undulations around the hydrothecal margin.......... *O. longissima.*

Obelia flabellata (Hincks). Fig. 35.

(*Campanularia flabellata* Hincks., Ann. and Mag. Nat. Hist., 3d series, vol. XVIII, p. 297.)

Trophosome.—Colony 8 to 10 inches high, consisting of a central geniculate stem, giving forth branches which themselves branch in a flabellate manner; stem not fascicled, annulated above the origins of the branches. Pedicels borne on rather short processes or shoulders of the branches, distinctly annulated, short. Hydrothecæ triangular in outline, margin entire.

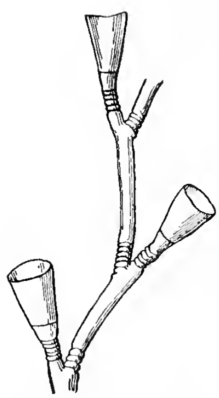
Gonosome.—Gonangia borne in axils of pedicels, oblong ovate, with a terminal collar and large round aperture. Medusæ not described, so far as I can ascertain.

Distribution.—Found in rocky tide pools (Hincks). Off Thimble Island, 4 to 5 fathoms. Woods Hole, in the passage (Verrill).

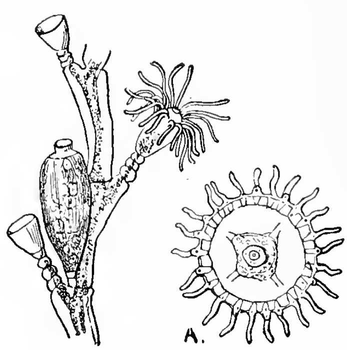
Obelia commissuralis McCr. Fig. 36.

(Proc. Elliott Soc., vol. I, No. 1, p. 197.)

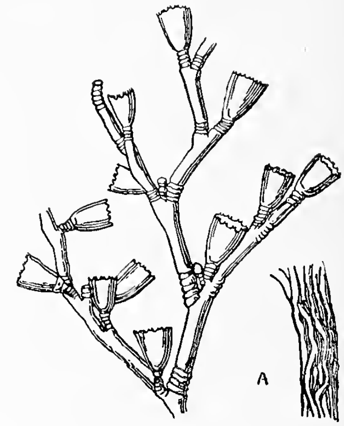
Trophosome.—Colony attaining a height of 6 to 8 inches, consisting of a central geniculate stem giving off branches as in *O. flabellata.* Pedicels not borne on distinct shoulders of the branches, distinctly annulated. Hydrothecæ campanulate, often subtriangular, but considerably deeper than in *O. flabellata.*



37. *Obelia dichotoma* (Linn.).



38. *Obelia geniculata* (Linn.).
A. Medusa.



39. *Obelia gelatinosa* (Pallas).
A. Portion of fascicled stem (enlarged),

Gonosome.—Gonangia much as in the last species, but larger and less distinctly ovoid. Medusæ at liberation with 16 marginal tentacles.

Distribution.—Growing profusely on docks and floating timbers. Abundant all along the New England coast.

The branching is exceedingly elegant and delicate, forming feathery verticillate tracery around the slender central stem.

Obelia dichotoma (Linn.). Fig. 37.

(*Sertularia dichotoma* Linn., Syst. Nat., p. 1312.)

Trophosome.—Colony branching irregularly, the branches tending to assume an erect posture, not subverticillate. Pedicels short, usually with 4 to 6 annulations, but sometimes with many. Hydrothecæ large, deeply campanulate, with straight sides and no teeth.

Gonosome.—Gonangia long, slender, widening toward distal end, and terminating in a beveled collar. Medusæ at liberation with 16 marginal tentacles.

Distribution.—Rather shallow water. Off Gay Head, 8 to 10 fathoms. (Verrill.)

I suspect that this is the same species as *Eucope pyriformis* A. Ag., but, not having seen his types, I can not be certain.

Obelia geniculata (Linn.) = *Eucope diaphana* L. Ag. (in part) = *Eucope alternata* A. Ag. Fig. 38.
(*Sertularia geniculata* Linn., Syst. Nat., p. 1312.)

Trophosome.—Colony usually consisting of a single geniculate stem bearing alternate pedicels on broad shoulder-like processes. Pedicels short, usually with 4 to 6 annulations. Hydrothecæ short, campanulate or subtriangular.

Gonosome.—Gonangia long, tapering gradually to basal end and terminating in a collar which is beveled and convex on its surface. Medusæ at liberation disk-shaped, with 24 marginal tentacles.

Distribution.—Growing profusely on docks, floating seaweed, etc. One of the commonest species in the Woods Hole region.

Obelia gelatinosa (Pallas) = *Laomedea gigantea* A. Ag. (*teste* Verrill). Fig. 39.
(*Sertularia gelatinosa* Pallas, Elenchus Zoophytorum, p. 116.)

Trophosome.—Colony sometimes attaining a height of 15 to 20 inches, profusely branched in a dendritic manner. Stem fascicled, with geniculate branches. Pedicels usually quite short, with 3 to 5 annulations. Hydrothecæ small, campanulate or subtriangular; margins armed with castellated or bimucronate teeth.

Gonosome.—Gonangia rather small, ovate, with collared aperture. Medusæ with 16 tentacles at time of liberation (Hincks).

Distribution.—Shallow water, often between tides, attached to timbers, etc. New Haven. Rhode Island coast. Vineyard Sound.

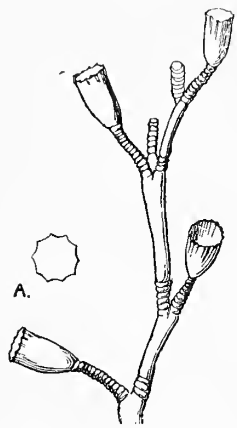
Obelia bicuspidata Clark. Fig. 40.
(Trans. Conn. Acad. of Sci., III, p. 58.)

Trophosome.—Colony attaining a height of about 33 inches. Stem fascicled, straight, irregularly branched. Pedicels longer than in the next species, and with 10 to 15 annulations. Hydrothecæ very deep, tubular, their margins armed with bimucronate teeth, between which lines originate which pass down the surface of the hydrothecæ.

Gonosome.—Unknown.

Distribution.—Found at a depth of 3 to 5 fathoms, from reefs near Thimble Island. Near Woods Hole, 19 fathoms.

40. *Obelia bicuspidata* Clark.



41. *Obelia longissima* Pallas. A. Outline of aperture of hydrotheca.

Obelia longissima (Pallas). Fig. 41.
(*Sertularia longissima* Pallas, Elenchus Zoophytorum, p. 119.)

Trophosome.—Colony attaining a height of 12 to 14 inches. Main stem fascicled, flexuose, giving off branches, which themselves branch in a palmate manner, the whole thus being subverticillate in effect. Pedicels of varying length, usually extensively annulated. Hydrothecæ rather deep, campanulate, the margins appearing at first sight to be without teeth, but upon careful examination proving to be armed with very shallow, regularly undulating teeth.

Gonosome.—Gonangia ovate, with collared apertures. Medusæ at the time of liberation with 20 to 24 tentacles (Hincks).

Distribution.—Woods Hole. Off Gay Head. Dredged by the *Fish Hawk* at station 7051, about 40 miles southeast of No Mans Land; depth, 3 fathoms.

As described by Hincks, this species has not a fascicled stem. Authentic specimens from England, however, have distinctly fascicled stems and agree well with American specimens.

Obelia bidentata Clark.
(Trans. Conn. Acad. of Sci., III, p. 58.)

Trophosome.—Like that of *O. bicuspidata*, except that it attains a larger size, has shorter pedicels, with 4 to 6 annulations, and proportionately wider hydrothecæ.

Gonosome.—Unknown.

Distribution.—On piles, Greenport, Rhode Island.

I have a specimen that to a certain extent intergrades between this species and the preceding, and therefore suspect that the two species may be identical.

GONOTHYRÆA.

Trophosome.—Stem not fascicled, branched. Hydrothecæ campanulate, with toothed margins.

Gonosome.—The gonangia producing fixed, medusiform sporosacs with apical filiform tentacles. The gonophores, when nearly mature, pass out of the gonangium and remain attached to its top until the spermatozoa or planulæ are discharged.

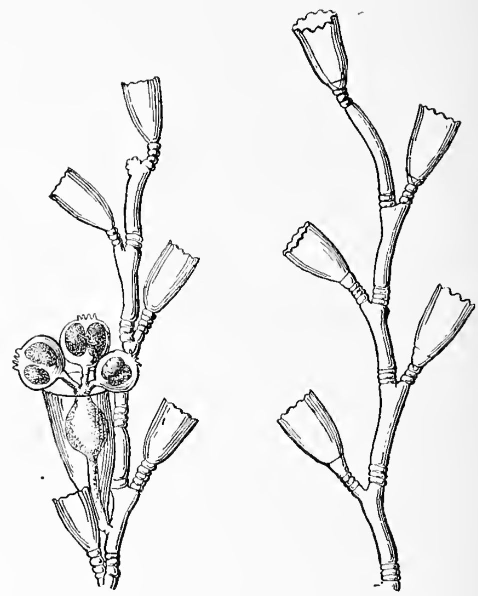
Gonothyræa loveni Allman. Fig. 42.

(Ann. and Mag. of Nat. Hist., 3d series, vol. 13, p. 374.)

Trophosome.—Stem irregularly branched, attaining a height of one-half to three-fourths inch, slightly flexuose, annulated above origins of pedicels. Pedicels short, with 2 to 5 annulations. Hydrothecæ deeply campanulate, gracefully tapering toward base, very thin and transparent around margin, which is quite variable in its dentition, the typical teeth being turreted and squared at the ends.

Gonosome.—Gonangia large, long, obconic, borne in the axils of the pedicels, each bearing, when mature, 3 to 5 modified medusæ on its summit. The sporosacs are attached to the top of the gonangium by short pedicels, and have at their upper end a circlet of short tentacles. They discharge their contents before becoming free.

Distribution.—Found on shells, stones, etc., in shallow water. Dr. H. C. Bumpus kindly sent to the writer some beautiful specimens from the coast of Rhode Island.



42. *Gonothyræa loveni* Allm. 43. *Gonothyræa tenuis* Clark, ?

Gonothyræa tenuis Clark, fig. 43, is reported from New Haven. There is no point either in the original description or in the figure published by Dr. Clark that enables me to separate this species from typical specimens of *G. loveni* from England. Professor Verrill says of this species: "Closely allied to *G. loveni*, but has narrow, elongated, obconic gonothecæ." As these terms are precisely applicable to the gonangia of *G. loveni*, I can not perceive any basis for considering *G. tenuis* a good species.

Gonothyræa hyalina Hincks is also reported by Professor Verrill as occurring off Watch Hill, Rhode Island. The writer, while at Plymouth, England, found completely intergrading specimens between this species and *G. loveni*.

HEBELLA (modified).

Trophosome.—Pedicels arising from a creeping rootstock. Hydrothecæ tubular, with entire margins and without opercula. Hydrothecal cavity separated from that of the pedicel by a partial septum. Hydranth with a conical proboscis.

Gonosome.—Gonangia producing free medusæ.

The genus as here defined would include several species which most authors place in the genus *Lafœa*.

Key to species of Hebella found in the Woods Hole region.

Hydrothecæ usually in pairs, doubly curved. Species almost always parasitic on *Sertularia cornicina* ..... *H. calcarata.*

Hydrothecæ irregularly distributed, small, not doubly curved. Species parasitic on various hydroids...... *H. pygmæa.*

Hebella calcarata (A. Ag.). Fig. 56.

(*Lafœa calcarata* A. Ag., North American Acalephæ, p. 122.)

Trophosome.—Colony parasitic, almost always on *Sertularia cornicina*, where it assumes a symmetrical mode of growth, the main stem growing straight up the front of the host and giving forth a pair of hydrothecæ immediately above each pair of the sertularian hydrothecæ. Pedicels very short and slender. Hydrothecæ large, curved outward, backward and upward; margin circular, entire. Hydranth with a conical hypostome and about 16 tentacles.

Gonosome.—Gonangia very large, borne on pedicels between the pairs of hydrothecæ. Medusæ at birth deeply campanulate, with two long marginal tentacles, and others in course of development; 4 radial canals and yellow-spotted proboscis.

Distribution.—Found attached to *Zostera* at Woods Hole by Mr. Walmsley. Vineyard Sound, 1 to 8 fathoms (Verrill).

This species was originally described by McCrady as a part of the sertularian on which it grows.

Hebella pygmæa (Alder) MS. Fig. 44.

(See British Hydroid Zoophytes, Hincks, p. 205.)

Trophosome.—Pedicels springing direct from a simple creeping rootstock, very short, annulated. Hydrothecæ minute, cylindrical, deep; aperture smooth, sometimes somewhat oblique, as in figure.

Gonosome.—Unknown.

Distribution.—Found on a polyzoon off Nantucket; Sankety Light east by south; depth, 24 fathoms. (Vinal Edwards.)

This minute species is identified with considerable doubt.

44. *Hebella pygmæa* (Alder).

CAMPANULINIDÆ (modified).

Trophosome.—Colonies branched or unbranched. Hydrothecæ borne on pedicels, tubular, ending in an operculum composed of converging segments. Hydranths with a conical proboscis.

Gonosome.—Gonangia producing planulæ, or free medusæ.

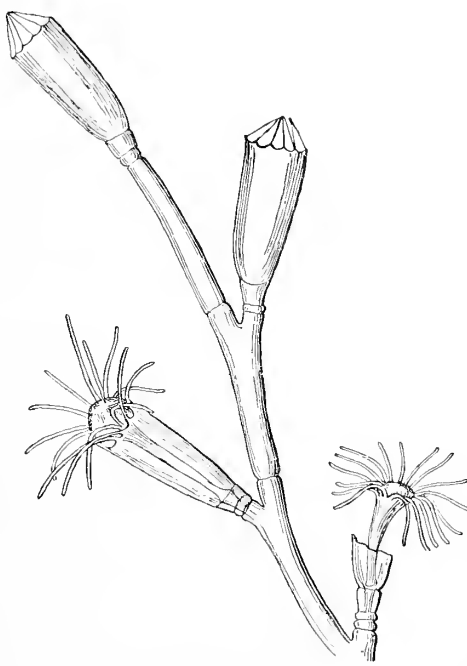
This family is here modified to include the genera *Lovenella* and *Calycella*, the former having heretofore been placed in the *Campanularidæ* and the latter in the *Lafœidæ*. Both agree with the genus *Campanulina* in having hydrothecæ with a segmented operculum and hydranths with a conical proboscis.

Key to genera of Campanulinidæ of Woods Hole region.

A. Colony usually branched.
- *a.* Hydrothecæ large, subcylindrical, with a well-defined sinuous margin at base of segmented operculum .... *Lovenella.*
- *a'.* Hydrothecæ much smaller, ovate in outline, the margin passing insensibly into the segments of operculum .... *Calycella.*

A'. Colony not regularly branched. Hydrothecæ not sessile, tubular, often with reduplicated margins ..... *Opercularella.*

A''. Colony not branched. Hydrothecæ sessile, tubular .... *Cuspidella*



45. *Lovenella grandis* Nutting.

LOVENELLA.

Trophosome.—Colony branched. Hydrothecæ deep, with a distinct sinuous margin crowned with operculum composed of several triangular segments which form a pointed covering to hydrotheca.

Gonosome.—Gonangia borne on the stems and producing free, bell-shaped medusæ with 8 tentacles in two sets, and 4 lithocysts.

Lovenella grandis, new species. Fig. 45.

Trophosome.—Stem simple, giving off regularly alternating, short, annulated pedicels, one from each internode. Hydrothecæ very large, cylindrical; margin with 10 regular sinuations from which arise the 10 sharply pointed segments of the operculum. Hydranths large with a conical proboscis which becomes dome-shaped on retraction, and about 16 rather rigid tentacles.

Gonosome.—Not known.

Distribution.—Dredged from Newport Harbor, off Castle Hill.

This beautiful species was given me for description by Mrs. Virginia Barrett Gibbs, of Newport.

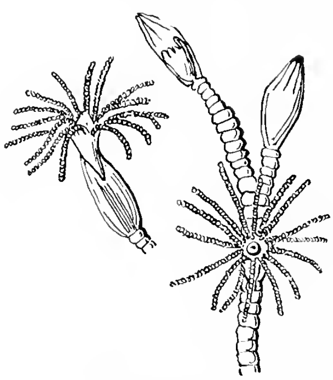
OPERCULARELLA.

Trophosome.—Stem annulated throughout. Hydrothecæ ovate in outline, the margin not distinct, the segments of the operculum appearing to be very thin and greatly elongated marginal teeth which converge to form the operculum.

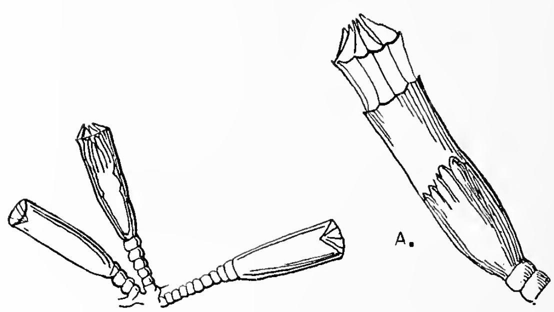
Gonosome.—The mature gonangia bear acrocysts.

Key to species of Opercularella found in the Woods Hole region.

Hydrothecæ larger, with more deeply cleft segments of the opercula .... *O. lacerata.*
Hydrothecæ smaller, with less deeply cleft segments of the opercula .... *O. pumila.*



46. *Opercularella lacerata* Hincks.



47. *Calycella syringa* (Linn.). A. Hydrotheca (enlarged).

Opercularella lacerata Hincks. Fig. 46.

(British Hydroid Zoophytes, p. 194.)

Trophosome.—Stem annulated throughout, sparsely branched, or unbranched. Hydrothecæ with short pedicels, oblong ovate in outline; opercular segments 8 to 10, very long and slender, somewhat curved. Hydranth with conical proboscis and about 16 tentacles.

Gonosome.—Gonangia large, ovate, borne on ringed pedicels, and, when mature, bearing globular acrocysts on their summits.

Distribution.—New Haven, Conn., on piles of Long Wharf. (Clark.)

Opercularella pumila Clark.

(Trans. Conn. Acad., vol. III, p. 61.)

Like *O. lacerata*, but with smaller hydrothecæ and less deeply cleft segments of the operculum.

In comparing Dr. Clark's description and figure with sketches of *O. lacerata* made by myself in England I have serious doubts as to the validity of the former species, but consider it best to let it stand here, as I have not seen the type specimens.

CALYCELLA.

Trophosome.—Stem a creeping rootstock parasitic on other species of hydroids, polyzoons, etc., sending forth short annulated pedicels bearing tubular hydrothecæ with distinct, segmented opercula.

Gonosome.—Gonangia oval, borne on the rootstock and, when mature, bearing globular acrocysts.

Calycella syringa (Linn.). Fig. 47.

(*Sertularia syringa* Linn., Syst. Nat., p. 1311.)

Trophosome.—Pedicels shorter than hydrothecæ, very deeply annulated. Hydrothecæ tubular, with thick horn-colored walls and slightly sinuated margins; opercular segments rather short, triangular, and capable of being drawn into the hydrotheca when the hydranth is retracted. There is often a sort of an addition or tubular extension beyond the end of the hydrotheca, with a distinct margin bearing the opercular segments.

Gonosome.—Gonangia oval, borne on short annulated pedicels and, when mature, with globular acrocysts.

Distribution.—Found abundantly in the Woods Hole region, growing over all sorts of plant-like marine organisms, especially other hydroids.

CUSPIDELLA.

Trophosome.—Hydrothecæ sessile with a conical operculum. Hydranths with a conical hypostome.

Gonosome.—Not known.

Cuspidella costata Hincks.

(British Hydroid Zoophytes, p. 210.)

Trophosome.—Hydrothecæ perfectly cylindrical and sessile, encircled with usually three sharply defined annulations dividing the hydrotheca externally into four zones; operculum composed of numerous segments, the distal ends of which can be retracted within the hydrotheca.

Gonosome.—Unknown.

Distribution.—Reported by Professor Verrill from Fisher Island Sound, 9 to 11 fathoms.

This species is identified with doubt by Verrill.

LAFŒIDÆ (modified).

The modification consists of the removal of the small monosiphonic species, such as *Lafœa pocillum*, which I have placed in Allman's genus *Hebella*, and the genus *Calycella*, which I have placed in the family *Campanulinidæ*.

Trophosome.—Stem fascicled. Hydrothecæ tubular, without a partial septum dividing the hydrothecal cavity from that of the pedicel; margin without teeth or opercula. Hydranths with a conical proboscis.

Gonosome.—Gonangia found in compact masses incrusting the fascicled stem, oblong, each female gonangium containing a single ovum. The gonosome of *Lafœa* was long regarded as a distinct hydroid organism under the name *Coppinia arcta*.[1]

LAFŒA.

This being the only genus of *Lafœidæ* found on the New England coast, it can be identified by the family characters as given above.

Key to the species of Lafœa found in the Woods Hole region.

Hydrothecæ short, almost sessile .... *L. dumosa.*
Hydrothecæ slender, with distinct pedicels which are waved or twisted .... *L. gracillima.*

Lafœa dumosa Fleming. Fig. 48.

(Phil. Journ., II, p. 83.)

Trophosome.—Stem simple, in the form of a creeping rootstock, or compound and erect. Hydrothecæ strong, large, tubular, with short, sometimes hardly evident, pedicels.

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[1] See New Hydroids from Alaska and Puget Sound, C. C. Nutting. Proc. U. S. N. M., vol. XXI, p. 747.

Gonosome.—Gonangia in masses, incrusting the fascicled stem, so closely crowded as to be pressed together, tubular or oblong oval with short bottle-shaped necks. Both sexes found in the same colony.

Distribution.—Found growing on other hydroids on Nantucket Shoals. (Verrill.)

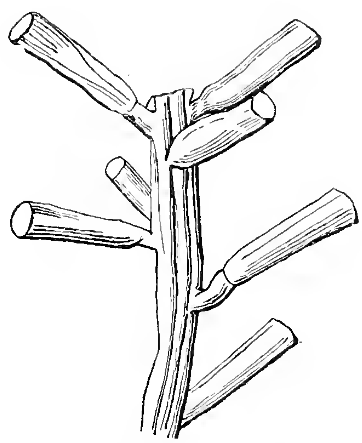
Lafœa gracillima (Alder). Fig. 49.

(*Campanularia gracillima*, Cat. Zooph. Northumb. and Durham, p. 39.)

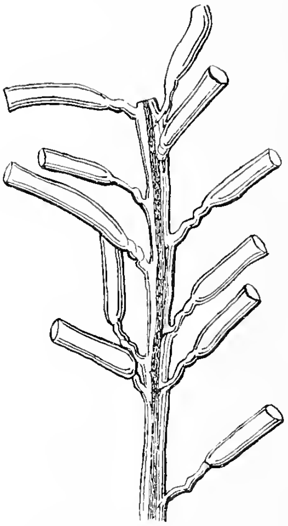
Trophosome.—Stem erect, fascicled, often irregularly branched. Pedicels slender, sinuous or apparently twisted. Hydrothecæ very slender, delicate in texture, often slightly curved.

Gonosome.—Much like that of *L. dumosa*, and heretofore known as *Coppinia arcta*.

Distribution.—Reported from the New England coast by Professor Verrill. Although not specifically reported from the Woods Hole region, it doubtless occurs there, as its distribution is much like that of *L. dumosa.*



48. *Lafœa dumosa* (Fleming).



49. *Lafœa gracillima* (Alder).

HALECIDÆ.

Trophosome.—Hydrothecæ alternate, reduced to the form of saucer-shaped hydrophores, usually borne on tubular pedicels; margins even, often reduplicated several times, and surrounded by a circlet of bright, bead-like dots. Hydranths large, with conical proboscis, not capable of retracting within the hydrophores.

Gonosome.—Gonangia producing planulæ, and usually different in the two sexes, that of the female often being surmounted by a pair of hydranths.

HALECIUM.

The single genus can be identified by the characters given above.

Key to species of Halecium found in the Woods Hole region.

A. Hydrophores borne on distinct pedicels.
- *a.* Stem fascicled.
  - *b.* Colony flabellate in form; aperture of female gonangium terminal, but not central. Pedicels short .... *H. halecinum.*
  - *b'.* Colony dendritic in form. Female gonangia with round lateral apertures. Pedicels short .... *H. beani.*
  - *b''.* Colony with slender branches. Female gonangia as in *H. halecinum*, but with end emarginate .... *H. gracile.*
- *a'.* Stem not fascicled, irregularly branched, annulated .... *H. tenellum.*

A'. Hydrophores sessile, borne directly on broadened shoulder of internodes of stem .... *H. articulosum.*

Halecium halecinum (Linn.). Fig. 50.

(*Sertularia halecina* Linn., Syst. Nat., p. 1308.)

Trophosome.—Colony attaining a height of 6 to 10 inches, erect, rigid; stem fascicled, pinnately branched, internodes short. Hydrophores on long trumpet-shaped pedicels, margins frequently reduplicated.

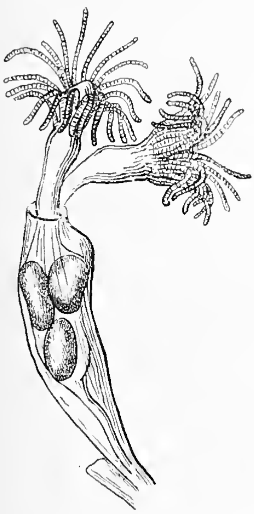
Gonosome.—Female gonangia in rows on upper side of branches, obconic in outline, with the aperture on one side of the truncated top, surrounded by a collar-like rim surmounted by a pair of hydranths. Male gonophores slender, oblong-ovate.

Distribution.—Abundant throughout the Woods Hole region, growing on shells, stones, etc., in shallow water.

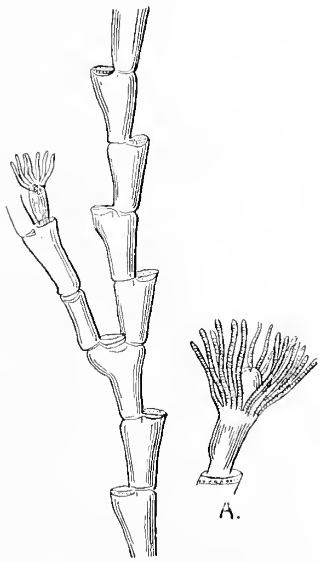
Halecium articulosum Clark. Fig. 51.

(Trans. Conn. Acad. of Sci., vol. III, p. 63.)

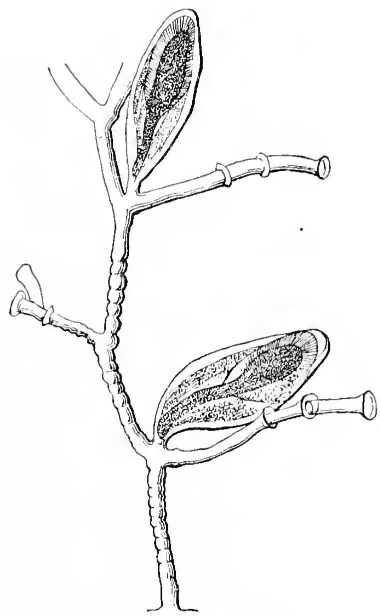
Trophosome.—Colony sometimes attaining a height of almost 2 feet; stem fascicled, branches very long and slender, the ultimate branchlets being pinnately arranged like those of the family *Plumularidæ.* Hydrophores sessile, alternate, borne on the broadened distal ends of the almost triangular internodes. Hydranths very large, with about 20 tentacles.



50. *Halecium halecinum* (Linn.). Gonangium bearing hydranths.



51. *Halecium articulosum* Clark. A. Hydranth (enlarged).



52. *Halecium tenellum* Hincks.

Gonosome.—Female gonangia obovate, with a latero-terminal aperture. Male gonangia long, slender, subcylindrical.

Distribution.—Long Island Sound (Verrill). The gigantic specimens referred to were secured by the *Fish Hawk,* station 7051, lat. N. 40° 46′, long. W. 70° 43′. Depth 31 fathoms. The largest specimen, and it is probably the largest known specimen of the *Halecidæ,* is now in the U. S. Fish Commission collection at Woods Hole.

Halecium tenellum Hincks. Fig. 52.

(Ann. and Mag. of Nat. Hist., 3d series, vol. VIII, p. 252.)

Trophosome.—Colony very small, not over half an inch in height; stem not fascicled, delicate, irregularly geniculate; branches straggling, irregular; internodes very long and irregularly annulated. Hydrophores borne on very long, tubular pedicels, irregularly arranged.

Gonosome.—Gonangia borne at origin of pedicels, very large, oblong-ovate in outline.

Distribution.—I find this species mentioned in my notes as occurring at Woods Hole, but the specimen seems to have been lost. The figure is from an English specimen.

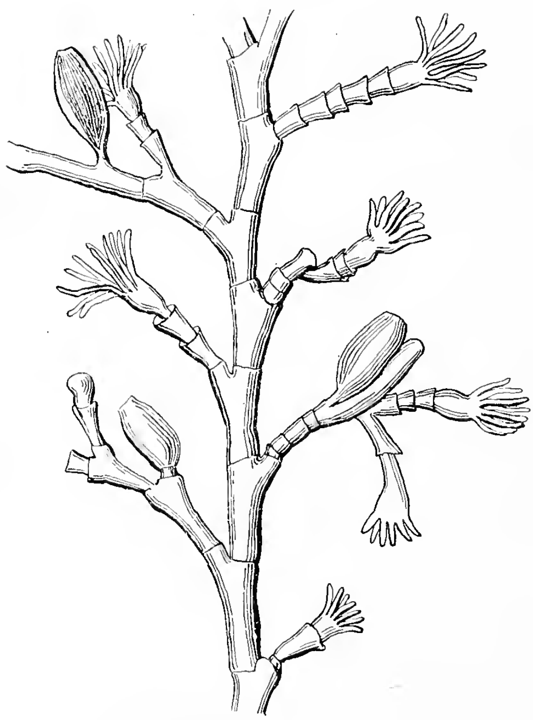
Halecium beani (Johnston). Fig. 53.

(*Thoa beani* Johnston, British Zoophytes, p. 120.)

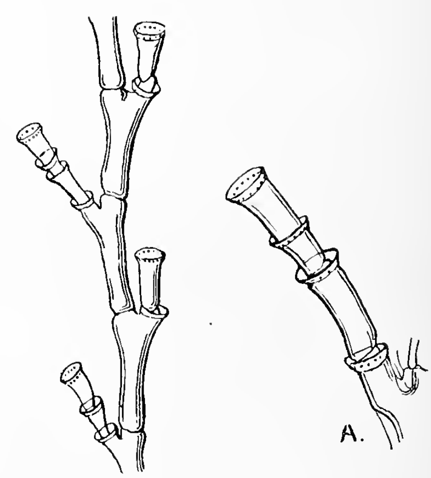
Trophosome.—Colony 2 to 5 inches high, branching in a dendritic manner, more delicate than *H. halecinum;* stem fascicled, the branches slender, the internodes divided by slightly oblique nodes. Hydrophores much as in *H. halecinum.*

Gonosome.—Female gonangia mitten-shaped, with the aperture lateral, representing the cut-off thumb of the mitten. Male gonangia oblong-ovate.

Distribution.—Found growing on bivalve shells at Woods Hole.



53. *Halecium beani* (Johnston).



54. *Halecium gracile* Verrill.
A. Hydrophores (enlarged).

Halecium gracile Verrill. Fig. 54.

(Invertebrated Animals of Vineyard Sound, p. 729.)

Trophosome.—Colony profusely branched; stem fascicled; branches ascending, slender, pinnately arranged, with slender internodes separated by oblique nodes. Hydrophores much as in *H. halecinum.*

Gonosome.—Female gonangia much as in *H. halecinum*, but with the end emarginate. Male gonangia oblong-ovate.

Distribution.—Buzzard's Bay; Vineyard Sound; near New Haven, on floating timber (Verrill).

Professor Verrill has kindly sent me a type specimen from which the figures were drawn. Although hard to differentiate succinctly from *H. halecinum*, it has a very distinct facies and mode of growth.

SERTULARIDÆ.

Trophosome.—Hydrothecæ sessile, more or less adnate to the stem, and arranged on both sides of the stem and branches. Hydranths with conical proboscis and a single whorl of filiform tentacles.

Gonosome.—Gonangia producing planulæ. No medusæ.

Key to the genera of Sertularidæ found in the Woods Hole region.[1]

A. Hydrothecæ in strictly opposite pairs, a pair to each internode of the stem or branch.
  a. Operculum, when present, in two pieces .... *Sertularia.*
  a′. Operculum, when present, in one piece only .... *Diphasia.*
A′. Hydrothecæ subopposite, usually deeply immersed, more than two to each joint of stem or branch .... *Thuiaria.*
A″. Hydrothecæ strictly alternate.
  a. Hydrothecæ placed on opposite sides of stem and branches .... *Sertularella.*
  a′. Hydrothecæ placed on the front of branches and curved alternately to the right and left .... *Hydrallmania.*

SERTULARIA.

Trophosome.—Colony usually branched; stems and branches divided into regular internodes, each of which bears a pair of strictly opposite hydrothecæ. Hydrothecæ either without an operculum or with a very delicate one composed of two pieces.

Gonosome.—Gonangia without an internal marsupium.

Key to species of Sertularia found in the Woods Hole region.

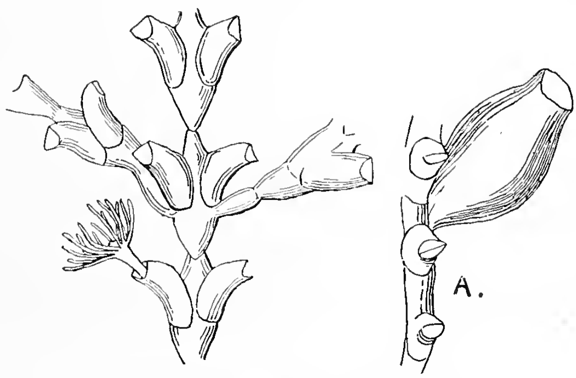
A. The two hydrothecæ composing a pair scarcely touching each other in front .... *S. pumila.*
A′. The two hydrothecæ in contact for at least half their length.
  a. The width of a pair of hydrothecæ at their bases considerably less than distance from bottom of hydrothecæ to the node below .... *S. cornicina.*
  a′. The width of a pair of hydrothecæ at their bases not much less than distance from bottom of hydrothecæ to the node below .... *S. complexa.*

Sertularia pumila Linn. Fig. 55.
(Syst. Nat., p. 1306.)

Trophosome.—Colony small, branched or unbranched; stem divided into regular internodes, each bearing a pair of hydrothecæ. Hydrothecæ stout, regularly curved, the approximated sides of a pair not in contact; aperture bilabiate, often showing a very delicate operculum composed of two valves.

Gonosome.—Gonangia ovate, with a short pedicel and a terminal collar containing the aperture.

Distribution.—Rather common in the Woods Hole region in shallow water. Often found growing over seaweed.



55. *Sertularia pumila* Linn.
A. Side view of branch bearing gonangium.

Sertularia cornicina (McCr.). Fig. 56.
(*Dynamena cornicina* McCr., Gymnophthalmata of Charleston Harbor, p. 102.)

Trophosome.—Colony usually of a single upright stem not over half an inch high. Hydrothecæ more slender than in *S. pumila* and the pairs are in contact for a considerable part of their contiguous sides. Colony almost invariably overgrown by a campanularian (*Hebella calcarata*) which the original describer took to be a part of the sertularian, the campanularian disposing its curved tubular hydrothecæ symmetrically in pairs above the pairs of hydrothecæ of the sertularian.

Gonosome.—Unknown.

Distribution.—Vineyard Sound, 8 fathoms, on *Halecium gracile* and on *Zostera* (Verrill). My specimens were sent by Mr. Walmsley to Professor Osborn, of Hamline University, labeled "*S. pumila.*"

[1] A satisfactory classification of this group is still to be devised. The one adopted here will do fairly well for the genera and species in the territory under consideration, but would be unsatisfactory if applied to the *Sertularidæ* in general.

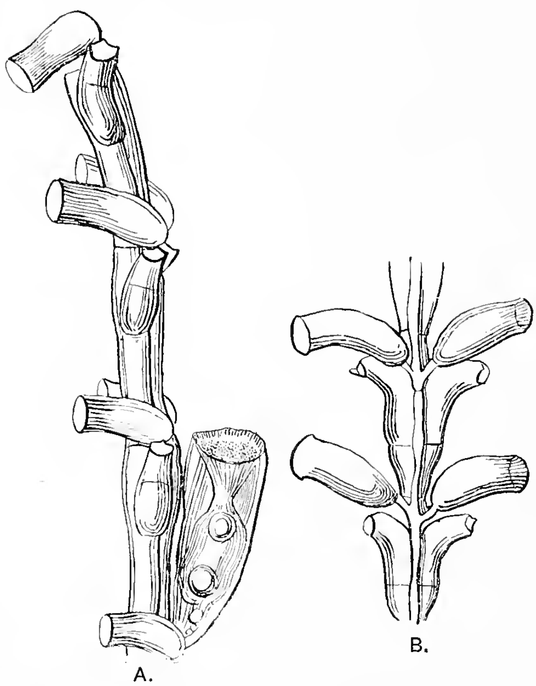
Sertularia complexa Clarke. Fig. 57.

(Bull. Mus. Comp. Zool., vol. v, No. 10, p. 245.)

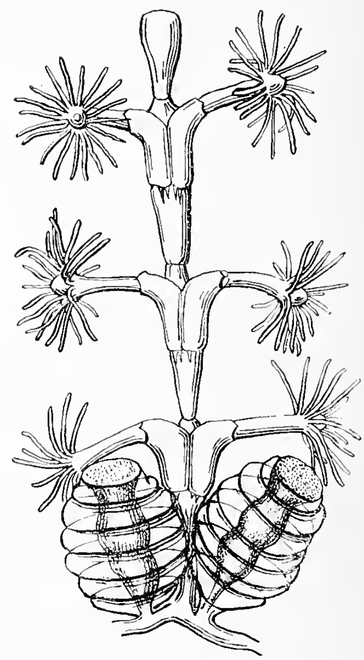
Trophosome.—Colony an unbranched erect stem attaining a height of about three-fourths inch. Hydrothecæ tubular, abruptly curved outward distally, aperture bilabiate; the two hydrothecæ of a pair adnate for more than their proximal half. Stem internodes below hydrothecæ slender, showing immediately below the hydrothecæ short internal, chitinous processes pointing downward from the hydrothecal floors. Hydranths with conical proboscis and about 20 tentacles.

Gonosome.—Gonangia produced usually in pairs at foot of stem, ovoid in form, beautifully and regularly annulated, resembling Chinese lanterns, collar terminal, with circular aperture and operculum.

Distribution.—Found by Mr. Walmsley near Woods Hole, and afterwards by myself, growing in great quantities over seaweed dredged from the bottom near Nobska Point.



56. *Sertularia cornicina* McCr., upon which *Hebella calcarata* (Ag.) is growing as a parasite. A. Lateral view. B. Front view.



57. *Sertularia complexa* Clarke.

This interesting species was originally found by the *Blake* off the coast of Yucatan, then reported from Australia by Professor Bale, and finally proves to be common near Woods Hole, where it has doubtless often been mistaken for *S. pumila*.

DIPHASIA.

Trophosome.—Colony regularly branching; stems and branches regularly divided into internodes, each of which bears a pair of opposite hydrothecæ. Hydrothecal margins even or sinuous, with an internal operculum consisting of a single piece.

Gonosome.—Gonangia cleft above into leaf-like segments, and containing a spherical, internal marsupial chamber.

Key to species of Diphasia found in the Woods Hole region.

Width of a pair of hydrothecæ at base nearly equal to their height........ *D. fallax.*
Width of a pair of hydrothecæ at base not much more than half their height........ *D. rosacea.*

Diphasia fallax (Johnston). Fig. 58.

(*Sertularia fallax* Johnston, British Zoophytes, 8th edition, p. 127.)

Trophosome.—Colony branched, the terminal branches often abruptly curved so as to form a hook or short coil. Hydrothecæ stout, with a wide, sinuous margin closed by an operculum hinged to its inner side.

Gonosome.—Female gonangia with four leaf-like expansions above; male gonangia with four terminal spines.

Distribution.—Shallow water, often growing on other hydroids. A specimen found in the U. S. Fish Commission collection at Woods Hole is labeled "E. by S., Sankety, Nantucket, 23 fathoms, V. N. E." Off Watch Hill, 17 to 21 fathoms. (Verrill.)

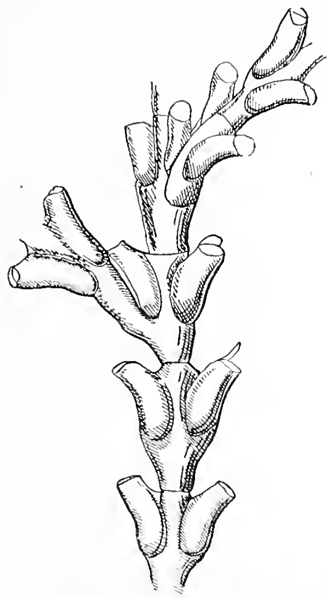
Diphasia rosacea (Linn.). Fig. 59.

(*Sertularia rosacea* Linn., Syst. Nat., 1306.)

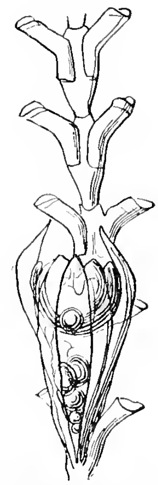
Trophosome.—Colony branched; branches more slender than in *D. fallax*, and more widely separated. Hydrothecæ delicate, transparent, slender, tubular, abruptly bent outward near the middle; aperture facing nearly upward, sinuous, closed with an internal operculum consisting of a single piece.

Gonosome.—Female gonangium pyriform, longitudinally ridged, with two prominent pointed processes on top, and a round internal marsupium; male gonangium "pyriform, curved toward the base, traversed by longitudinal lamellated ridges, which rise above into spinous processes around a slender tubular orifice." (Hincks.)

Distribution.—Fisher Island Sound, 9 to 11 fathoms. (Verrill.)



58. *Diphasia fallax* (Johnston).



59. *Diphasia rosacea* (Linn.).

SERTULARELLA.

Trophosome.—Colony usually branching; stem and branches divided into regular internodes, each bearing one or two hydrothecæ. Hydrothecæ strictly alternate, borne on opposite sides of the branch, usually with toothed margins provided with an operculum consisting of more than one piece.

Gonosome.—Gonangia as in *Sertularia*, but usually more or less annulated.

Key to species of Sertularella found in the Woods Hole region.

A. Hydrothecal margin without teeth or operculum .... *S. abietina.*
A′. Hydrothecal margin with three teeth .... *S. tricuspidata.*
A″. Hydrothecal margin with 4 teeth.
  a. Teeth obscure. Hydrothecæ fusiform, deeply annulated or wrinkled transversely .... *S. rugosa.*
  a′. Hydrothecæ very large, sometimes corrugated above. Branches approximate .... *S. gayi.*
  a″. Hydrothecæ medium-sized, smooth. Branches irregular and distant .... *S. polyzonias.*

Sertularella abietina (Linn.). Fig. 60.

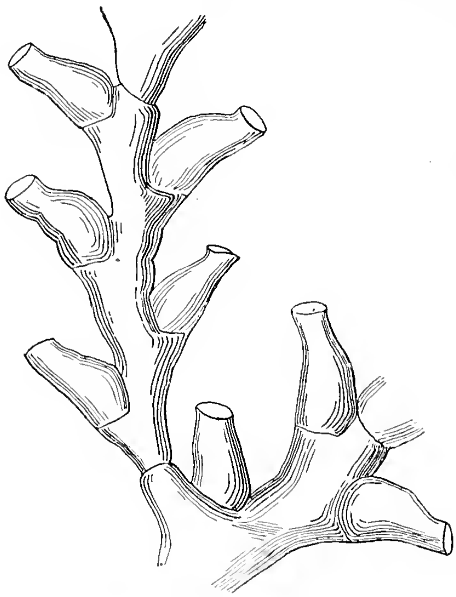
(*Sertularia abietina* Linn., Syst. Nat., p. 1307.)

Trophosome.—Colony pinnately branched; branches thick and coarse, approximate, divided into internodes, each of which bears one or two hydrothecæ; nodes oblique. Hydrothecæ large, alternate, bulging below and narrowing above to a tubular neck with a round, even aperture without an operculum.

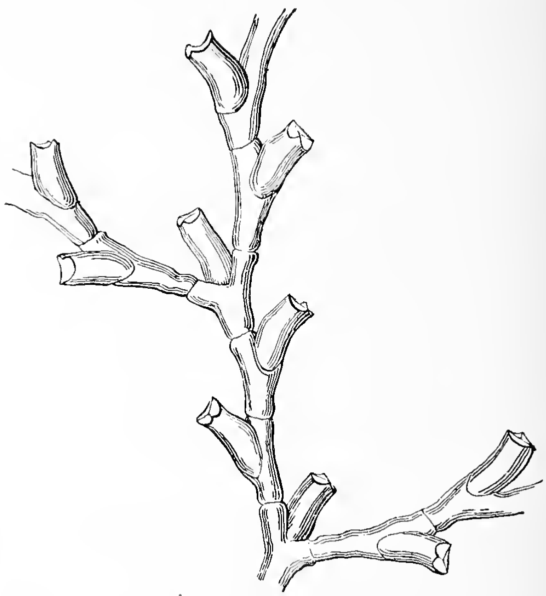
Gonosome.—Gonangia "subsessile, ovate, smooth, with an even, shortly tubulous mouth." (Hincks.)

Distribution.—A specimen in the U. S. Fish Commission collection at Woods Hole bears the label: "E. by S., Sankety light, 20 fath."

This species has always hitherto been placed in the genus *Sertularia*. Its strictly alternate hydrothecæ, however, make it necessary to consider it a *Sertularella* in accordance with the definition given above.



60. *Sertularella abietina* (Linn.).



61. *Sertularella tricuspidata* (Alder).

Sertularella tricuspidata (Alder). Fig. 61.

(*Sertularia tricuspidata* Alder, Cat. Zooph. North and Durh., p. 21.)

Trophosome.—Colony slender, branches alternate, divided into regular internodes, each of which bears an hydrotheca. Hydrothecæ cylindrical, slightly curved, distant, with a 3-toothed margin and 3-parted operculum.

Gonosome.—Gonangia deeply ringed, ovate, with a constricted tubular neck and circular orifice.

Distribution.—A specimen in the U. S. F. C. collection at Woods Hole bears the label "E. by S., Sankety light, 25 fath."

Sertularella rugosa (Linn.). Fig. 62.

(*Sertularia rugosa* Linn., Syst. Nat., p. 1308.)

Trophosome.—Colony minute, unbranched, or sparingly branched; internodes short, each bearing an hydrotheca. Hydrothecæ fusiform, very deeply and conspicuously marked with annular corrugations; aperture quadrangular, rather obscurely toothed; teeth 4; operculum composed of 4 pieces.

Gonosome.—Gonangia like the hydrothecæ, but much larger.

Distribution.—Noank, on piles of wharf. Off Watch Hill, 17 to 21 fathoms. (Verrill.)

Sertularella polyzonias (Linn.). Fig. 63.

(*Sertularia polyzonias* Linn., Syst. Nat., p. 813.)

Trophosome.—Colony branched in an irregular manner, the branches alternate, but not equally distant, divided into regular internodes, each of which bears an hydrotheca; nodes oblique. Hydrothecæ swollen below, narrowing above to a margin with 4 shallow teeth and an operculum of 4 pieces.

Gonosome.—Gonangia ovate, corrugated, with a short pedicel and quadrate aperture.

Distribution.—"Off New London, 6 fath.; Gardener Bay, 6 to 8 fathoms; Block Island Sound, 17 to 24 fathoms." (Verrill.)

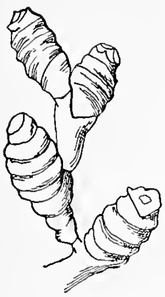
Sertularella gayi (Lamx.). Fig. 64.

(*Sertularia gayi* Lamx., Exposition Méthodique, p. 12.)

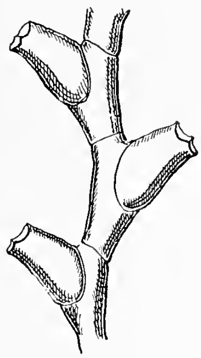
Trophosome.—Like the last, but much more robust. Branches regularly pinnate and approximate. Hydrothecæ much larger, often corrugated on the upper side.

Gonosome.—Gonangia with a 2-toothed aperture.

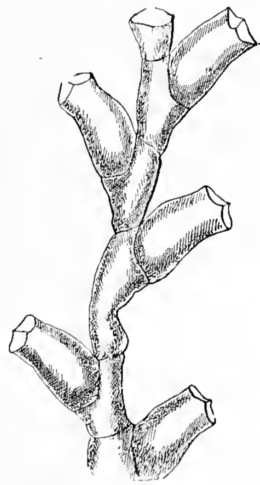
Distribution.—A specimen in the U. S. Fish Commission collection at Woods Hole bears the label "E. by S., Sankety Light, Nantucket, 25 fath." This specimen has much larger and coarser hydrothecæ than specimens from England, and may represent a distinct species.



62. *Sertularella rugosa* (Linn.).



63. *Sertularella polyzonias* (Linn.).



64. *Sertularella gayi* (Linn.).

THUIARIA.

Trophosome.—Colony branched; stem and branches divided into internodes each of which bears more than two opposite or subopposite hydrothecæ which are usually deeply immersed in the stem. Hydrothecæ tubular, or flask-shaped, with bilabiate apertures.

Gonosome.—Gonangia much like those of *Sertularia.*

Key to species of Thuiaria found in the Woods Hole region.

A. Stem long and slender, bearing slender branches which subdivide dichotomously. Gonangia bimucronate.
  a. Hydrothecæ free for about their distal one-third .... *T. argentea.*
  a′. Hydrothecæ immersed almost to the orifice .... *T. cupressina.*
A″. Stem and branches rigid, the latter stiff and subverticillately arranged. Gonangia without mucronate processes on end .... *T. thuja.*

Thuiaria argentea (Ellis & Solander). Fig. 65.

(*Sertularia argentea* Ell. & Sol., Zooph., p. 38.)

Trophosome.—Colony breaking up basally into long, slender main branches which give off spirally set, closely approximated, secondary branches which branch dichotomously, each forming a graceful flabellate structure; internodes rather slender, each bearing a group of several hydrothecæ. Hydrothecæ subalternate, tubular, their distal ends curving gently outward, so that about the terminal one-third is free; aperture armed with two opposite teeth, one much longer than the other.

Gonosome.—Gonangia with two lateral projections and a central terminal orifice.

Distribution.—Vineyard Sound, Long Island Sound, and other parts of the coast. Very common in depths from 1 to 20 fathoms.

A

65. *Thuiaria argentea* (Ell. & Sol.)
A. Gonangium.

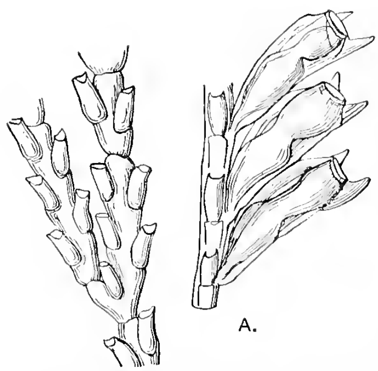
Thuiaria cupressina (Linn.). Fig. 66.

(*Sertularia cupressina* Linn., Syst. Nat., p. 1308.)

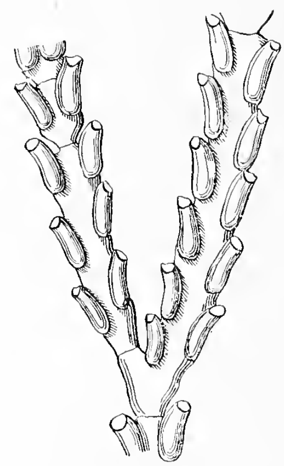
Trophosome.—Colony consisting usually of a single very long and graceful central stem which gives off alternate branches which again divide dichotomously into long alternate branchlets; giving the appearance of a verticillate arrangement. Internodes much shorter than in the last species, each bearing several pairs of subopposite hydrothecæ. Hydrothecæ immersed nearly to their ends, tubular, rather straight, with a not very pronounced bilabiate aperture.

Gonosome.—Gonangia borne in rows on upper sides of pinnules, shaped like those of *T. argentea.*

Distribution.—Vineyard Sound (Verrill). A specimen in the U. S. Fish Commission collection at Woods Hole is labeled, "E. by S. Sankety Light, 25 fath."



66. *Thuiaria cupressina* (Linn.). A. Gonangia.



67. *Thuiaria thuja* (Linn.).

Thuiaria thuja (Linn.). Fig. 67.

(*Sertularia thuja* Linn., Syst. Nat., p. 1308.)

Trophosome.—Stem rigid, sharply and finely geniculate, without branches on lower portion; branches forming spirals, each dichotomously branched and forming a flabellate structure. All of the branches and branchlets are stiff and harsh, very different from the graceful structures of the preceding species; internodes very thick, each bearing several pairs of closely approximated subopposite hydrothecæ, the top of one often reaching to bottom of one immediately above. Hydrothecæ tubular, somewhat swollen below, apertures with two rather inconspicuous opposite teeth of about the same size.

Gonosome.—Gonangia ovate, without lateral spines, and with a short collar and round aperture.

Distribution.—Off Nantucket. (Vinal Edwards).

HYDRALLMANIA.

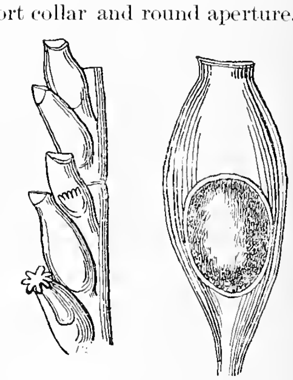
Trophosome.—Stem branched, the branches plume-like. Hydrothecæ in groups on one side of terminal branches, arranged in an alternate manner, curving to right and left.

Gonosome.—Gonangia ovate, with a terminal aperture surrounded by a slight collar.

Hydrallmania falcata (Linn.). Fig. 68.

(*Sertularia falcata* Linn., Syst. Nat., p. 1309.)

Trophosome.—Stem slender, without hydrothecæ; branches plume-like, the branchlets divided into internodes, each of which bears a group of several hydrothecæ on its front or upper side. Hydrothecæ flask-shaped, swollen below, narrow above, curved distally and ending in a bidentate aperture with an operculum.



68. *Hydrallmania falcata* (Linn.).
A. Portion of branch, side view.
B. Gonangium.

Gonosome.—Gonangia as described above.

Distribution.—Common in rather deep water throughout the Woods Hole region.

PLUMULARIDÆ.

Trophosome.—Hydrothecæ sessile, usually adnate by one side, arranged on the upper sides of the hydrocladia or hydrotheca-bearing branchlets. Nematophores[1] always present.

Gonosome.—Gonangia often inclosed in protective contrivances, such as modified branches or pod-shaped receptacles called "corbulæ." No medusæ.

Key to genera of Plumularidæ found in the Woods Hole region.

A. Nematophores trumpet-shaped, not immovably fixed to the hydrothecæ.
  a. Branching dichotomous, the hydrocladia springing from the upper side of the branches .... *Monostæchas.*
  a'. Branching strictly pinnate, the hydrocladia, or some of them, forked .... *Schizotricha.*
  a''. Branching verticillate or scattered. Cœnosarc canaliculated in main stem .... *Antennularia.*
A'. Nematophores not trumpet-shaped, immovably fixed to hydrothecæ or other parts of colony. Gonangia protected by special, usually forked, branches bearing nematophores without hydrothecæ......... *Cladocarpus.*

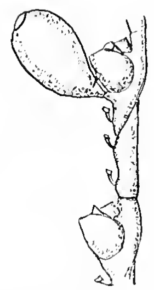
MONOSTÆCHAS.

Trophosome.—Colony dichotomously branched. Hydrocladia borne on upper sides of branches.

Gonosome.—Gonangia ovoid, borne at bases of hydrothecæ.

Monostæchas quadridens (McCr.). Fig. 69.

(*Plumularia quadridens* McCrady, Proc. Elliott Soc., vol. 1, No. 1, p. 199.)



69. *Monostæchas quadridens* (McCr.).

Trophosome.—Colony erect, composed of a main stem with branches which themselves branch dichotomously, bearing hydrocladia at their points of junction and also on their upper sides; hydrocladia composed of internodes, every alternate one of which bears an hydrotheca. Hydrothecæ cup-shaped, with even margins, adnate for about half their length. Nematophores trumpet-shaped, three associated with each hydrotheca, and usually two on each internode of hydrocladium that does not bear hydrothecæ; a row of nematophores is also found on the upper side of each branch from which hydrocladia spring.

Gonosome.—Gonangia ovoid or pyriform, borne on short pedicels just below the hydrothecæ.

Distribution.—Dredged by the *Albatross* near Marthas Vineyard. Depth, 22 fathoms. The species is common southward to the West Indies in moderate depths.

SCHIZOTRICHA.

Trophosome.—Colony consisting usually of a cluster of simple, upright stems, giving forth hydrocladia in a pinnate manner. Hydrocladia in mature specimens forked.

Gonosome.—Gonangia ovoid, tubular or cornucopia-shaped, borne on the main stem, branches, or hydrocladia.

Key to species of Schizotricha found in the Woods Hole region.

An hydrotheca in the axil of each hydrocladium .... *S. tenella.*
No hydrothecæ in the axils of the hydrocladia... *S. gracillima.*

Schizotricha tenella (Verrill). Fig. 70.

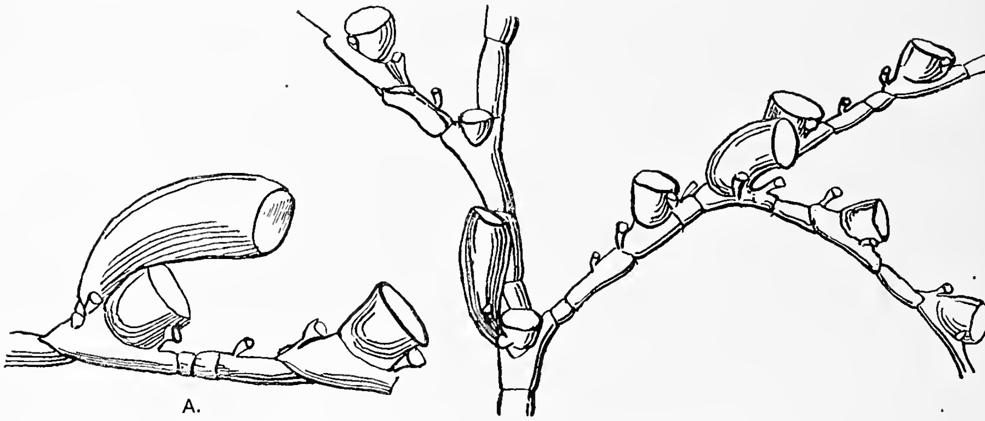
(*Plumularia tenella* Verrill. Invertebrated Animals of Vineyard Sound, p. 731.)

Trophosome.—Colony in the form of very delicate white plumes, 1 to 3 inches high, each plume consisting of a central stem giving off alternate hydrocladia with hydrotheca at base of each; hydrocladia often forked in mature specimens, with internodes and hydrothecæ much as in the last species, but with an additional short internode often intercalated. Nematophores as in the last species, except that there is but one to each intermediate internode.

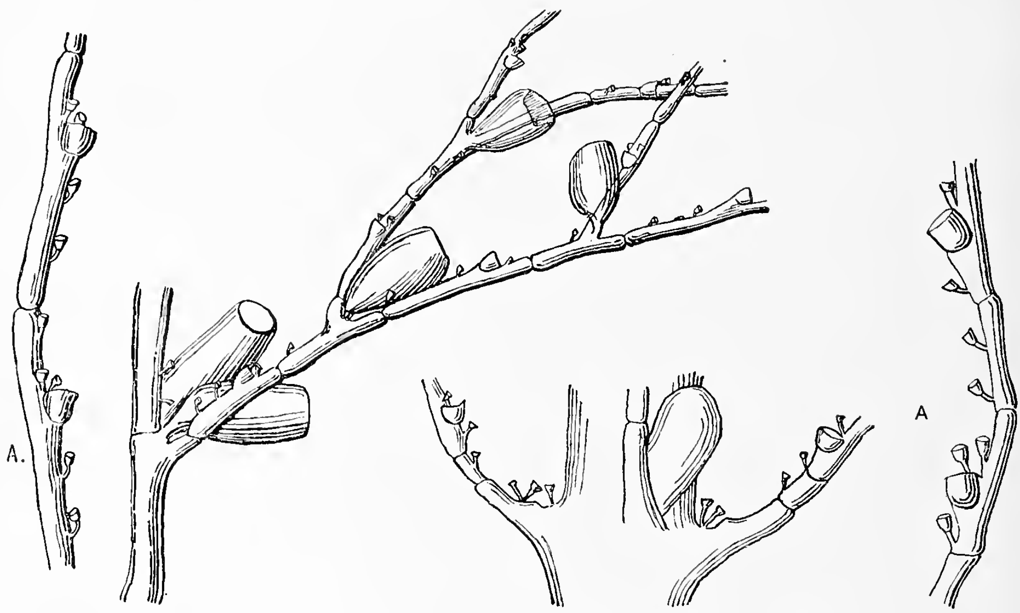
[1] The nematophores are minute trumpet-shaped or tubular organs composed of chitin and usually associated with the hydrothecæ, two, one on each side, being found near where the margin of the hydrotheca joins the stem to which it is adnate, and one just in front of the bottom of the hydrotheca. Others are found on the branches, stem, and protective contrivances which inclose the gonangia. The nematophores contain highly remarkable structures known as sarcostyles that are capable of enormous extension. They are morphologically "persons" of the colony.

Gonosome.—Gonangia curved, cornucopia-shaped, borne on slender pedicels at the bases of the hydrothecæ and having one or two nematophores on the basal portion.

Distribution.—Found abundantly on the piles of the wharves at Woods Hole and Vineyard Haven. Off Gay Head, 8 to 10 fathoms; Vineyard Sound, 8 fathoms. (Verrill.)



70. *Schizotricha tenella* (Verrill). A. Part of hydrocladium (enlarged).



71. *Schizotricha gracillima* (Sars).
A. Part of hydrocladium (enlarged).

72. *Antennularia antennina* (Linn.).
A. Part of hydrocladium (enlarged).

Schizotricha gracillima (Sars)=*Plumularia verrillii* Clark. Fig. 71.

(*Plumularia gracillima* Sars. Bidrag til Kundskab om Dyrelivet paa vore Havbanker.)

Trophosome.—Colony consisting of a main stem, which gives off plumose branches near its base. Branches consisting of a slender shaft, giving off alternate rather distant hydrocladia, which are forked and divided into rather distinct internodes which are long and slender and separated by straight nodes. Hydrothecæ small, cup-shaped, almost entirely adnate behind. A pair of trumpet-shaped nematophores are inserted just above the aperture of the hydrotheca, another single one below its base, and others scattered rather irregularly along the hydrocladia and stem.

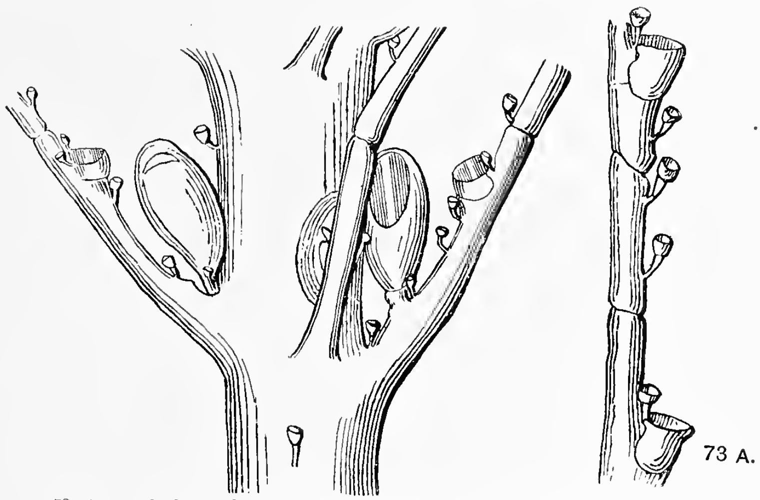
Gonosome.—Gonangia subcylindrical, somewhat swollen below, not curved, borne usually at the origin and forkings of the hydrocladia.

Distribution.—Eastport, Me. (Verrill). It is altogether probable that it occurs in the deeper water in the Woods Hole region. I have included it here to enable collectors to identify it if found.

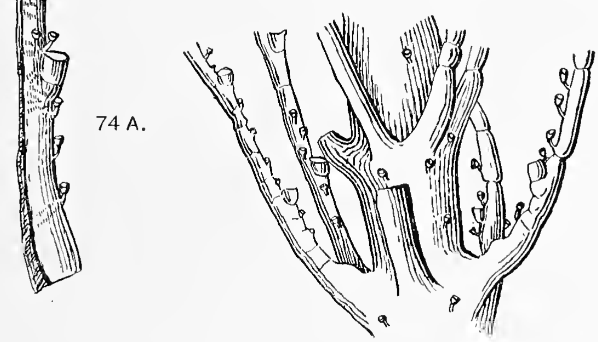
ANTENNULARIA.

Trophosome.—Hyrocladia arranged in verticels or whorls around stem. Stem with canaliculated cœnosarc, the canals being just under the periderm and not well seen except with transmitted light.

Gonosome.—Gonangia borne usually in the axils of the hydrocladia, not protected by gonangia or other special contrivances.



73. *Antennularia americana* Nutting. 73 A. Part of hydrocladium (enlarged).



74. *Antennularia rugosa* Nutting. 74 A. Part of hydrocladium (enlarged).

Key to species of Antennularia found in the Woods Hole region.

A. A node between the first hydrotheca on each hydrocladium and the stem from which it springs.......... *A. antennina.*
A′. No node between the first hydrotheca and stem.
  a. At least two nodes between adjacent hydrothecæ .... *A. americana.*
  a′. Hydrocladial nodes distant and usually absent .... *A. rugosa.*

Antennularia antennina (Linn.) Fig. 72.

(*Sertularia antennina* Linn., Syst. Nat., 1310.)

Trophosome.—Colony composed of a cluster of upright stems with whorls of hydrocladia at regular intervals; hydrocladia borne on stout processes from the stem, the first internode being without

hydrotheca, the next with one on its proximal half, and the rest of the hydrocladium being made up of alternating hydrothecate and intermediate internodes. Hydrothecæ cup-shaped, margin entire. Nematophores trumpet-shaped, a pair near the top of each hydrotheca, one below its base in front, two on each intermediate internode, and others on the stem.

Gonosome.—Gonangia borne on bases of hydrocladia, ovoid, deep, with subterminal aperture.

Distribution.—Off Gay Head, 18½ fathoms. Newport Harbor; Woods Hole; off Block Island. (George Gray.)

Antennularia americana Nutting. Fig. 73.

(Monograph of American Hydroids, part 1, The Plumularidæ, p. 69.)

Trophosome.—Colony composed of slender, erect stems bearing hydrocladia usually in whorls of 4. Proximal hydrotheca on each hydrocladium borne on a long process from the stem, there being no node between it and the stem. Otherwise the arrangement of the internodes, hydrothecæ, and nematophores are as in the preceding species.

Gonosome.—Gonangia oblong-ovate, with a subterminal lunate aperture.

Distribution.—Off Marthas Vineyard, *Albatross*. Waters of Rhode Island (specimen from Dr. H. C. Bumpus).

This species, although greatly resembling *A. antennina*, differs constantly in the characters given. In some cases, where a hydrocladium has been broken off and regenerated, there will be a node below the proximal hydrotheca. Otherwise the character is constant.

Antennularia rugosa Nutting. Fig. 74.

(Monograph of American Hydroids, part 1, The Plumularidæ, p. 70.)

Trophosome.—Colony consisting of upright stems which give off hydrocladia in whorls of 6 or 8, no node between the proximal hydrotheca on each hydrocladium and the stem. Hydrocladia supported by a remarkable thickening of the perisarc on the lower side of the proximal portion of each. Nodes very distant and irregular, but the interiors of the hydrocladia have numerous annular thickenings of the periderm that somewhat resemble nodes. Hydrothecæ deeper than in the other species. A pair of nematophores inserted on a level with top of the hydrotheca, and others scattered along the fronts of the internodes and around the stem.

Gonosome.—Not known.

Distribution.—Off Marthas Vineyard, 46 fathoms. (*Albatross.*)

CLADOCARPUS.

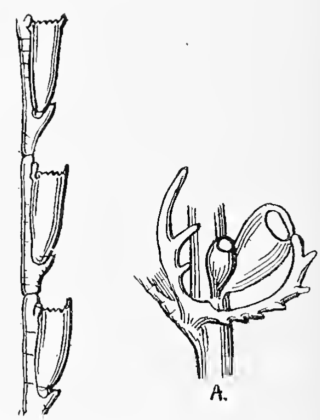
Trophosome.—Colony branched. Hydrocladia not forked. Nematophores neither movable nor trumpet-shaped.

Gonosome.—Gonangia borne on the stem and protected by special branchlets which spring from near the bases of the hydrocladia and bear nematophores but no hydrothecæ.

Cladocarpus flexilis Verrill. Fig. 75.

(Report Com. Fish and Fisheries, 1883, p. 517.)

Trophosome.—Stem not fascicled, long and slender; hydrocladia pinnately arranged, alternate, not forked, divided into internodes, each of which bears an hydrotheca and has its cavity divided by internal ridges. Hydrothecæ deep, subcylindrical, aperture horizontal, with a single strong anterior tooth and a number of shallow lateral teeth or sinuations. Nematophores tubular, a pair slightly overtopping the hydrothecal margin, and a single one below each hydrotheca, its end not rising much above the level of the bottom of the latter.



75. *Cladocarpus flexilis* Verrill.
A. Gonangia with protective branchlets.

Gonosome.—Gonangia growing on front of stem, protected by special branches borne on the bases of hydrocladia and branched like deers' horns, each branch bearing a row of nematophores.

Distribution.—Found in moderately deep water at various points along the Atlantic coast.

HYDROID MEDUSÆ FOUND IN THE WOODS HOLE REGION.

A monographic account of the medusæ is in course of preparation by an eminent authority, and the present writer therefore does not desire to discuss the medusæ in a systematic way, but hopes that the key herewith presented will be of service in identifying the medusæ known to occur in the region. No attempt has been made to describe new species or to define families, genera, or other groups. The classification conforms, so far as possible, to the plan of the preceding part of this work when the hydroid form is known. Otherwise the names are the same as those found in Alexander Agassiz's work, North American Acalephæ. Almost all of the illustrations are from specimens taken at Woods Hole and Newport, and sketched by the author.

Key for the identification of the Hydroid medusæ found in the Woods Hole region.

A. Ovaries attached to the proboscis walls and never found along the radial canals. Otocysts never present.
- *a.* Radial canals 4 unbranched.
  - *b.* A single conspicuous marginal tentacle. Others, if present, much smaller.
    - *c.* Proboscis not more than one-half length of bell cavity .... *Euphysa virgulata.*
    - *c'.* Proboscis more than one-half length of bell cavity.
      - *d.* A single greatly enlarged tentacle from which secondary medusæ arise .... *Hybocodon prolifer.*
      - *d'.* One large and 3 much smaller tentacles. No secondary medusæ .... *Corymorpha pendula.*
  - *b'.* Two conspicuous marginal tentacles. Others, if present, much smaller.
    - *c.* Bell with a distinct apical projection.
      - *d.* Apical projection a lengthened cone .... *Stomotoca apicata.*
      - *d'.* Apical projection dome-shaped. Tentacles bearing stalked nematocyst batteries .. *Gemmaria cladophora.*
    - *c'.* Bell evenly rounded, without apical projection.
      - *d.* Tentacles bearing stalked batteries of nematocysts .... *Corynitis agassizii.*
      - *d'.* Tentacles normal .... *Perigonimus jonesii.*
  - *b''.* Four tentacles of approximately equal length.
    - *c.* Proboscis and tentacles very long and slender.
      - *d.* Bell outline subspherical .... *Coryne mirabilis.*
      - *d'.* Bell outline subconical .... *Dipurena conica.*
    - *c'.* Proboscis short, not reaching bell opening.
      - *d.* Tentacles tightly coiled. Bell with 8 meridional lines of lasso cells .... *Ectopleura ochracea.*
      - *d'.* Tentacles rudimentary. No lines of lasso cells .... *Pennaria tiarella.*
      - *d''.* Tentacles functional. Radial canals very broad .... *Hydrichthys mirus.*
  - *b'''.* Eight tentacles of approximately equal length.
    - *c.* Tentacles strong, functional. Proboscis bearing secondary medusæ .... *Dysmorphosa fulgurans.*
    - *c'.* Tentacles rudimentary. No secondary medusæ .... *Stylactis hooperi.*
  - *b''''.* Tentacles more than 8, of approximately equal size when full grown, and disposed at regular intervals.
    - *c.* A large globular or subconical process on apex of bell .... *Turris vesicaria.*
    - *c'.* Bell evenly rounded above .... *Turritopsis nutricula.*
  - *b'''''.* Tentacles in groups or bunches.
    - *c.* Four clusters of tentacles.
      - *d.* Proboscis small and slender.
        - *e.* A pair of erect clavate tentacles in each group .... *Nemopsis bachei.*
        - *e'.* Tentacles much alike .... *Bougainvillia carolinensis.*
      - *d'.* Proboscis large and broad .... *Bougainvillia superciliaris.*
    - *c'.* Eight clusters of marginal tentacles .... *Lizzia grata.*
- *a'.* Radial canals 4, branched at their distal ends .... *Willia ornata.*
- *a''.* Radial canals many, bell cup-shaped .... *Orchistoma tentaculata.*

A'. Ovaries attached to the radial canals, often also to the proboscis. Otocysts usually present.
- *a.* Radial canals 4.
  - *b.* Marginal tentacles 4, sometimes with lateral cirri.
    - *c.* Proboscis very long, reaching far beyond the velum.
      - *d.* A swelling at base of each tentacle .... *Eutima mira.*
      - *d'.* No swelling at bases of tentacles .... *Eutima limpida.*
    - *c'.* Proboscis short. Bell deep.
      - *d.* Tentacles with lateral cirri.
        - *e.* Club-shaped appendages between bases of tentacles .... *Hebella calcarata* (juv.).
        - *e'.* No club-shaped appendages.
          - *f.* Two otocysts between bases of adjacent tentacles .... *Eucheilota ventricularis.*
          - *f'.* Three otocysts between bases of adjacent tentacles .... *Eucheilota duodecimalis.*
      - *d'.* Tentacles without lateral cirri .... *Clytia bicophora* (juv.). *Clytia noliformis* (juv.).

b'. Marginal tentacles, 16 or more.
 c. Proboscis very long, reaching far below velum ..... *Tima formosa*
 c'. Proboscis short.
  d. Tentacles with lateral cirri at bases ..... *Hebella calcarata.*
  d'. Tentacles without lateral cirri.
   e. Bell disk-shaped. Proboscis without fimbriated tentacles.
    f. Otocysts on bases of tentacles.
     g'. Tentacles 24 at liberation of medusa ..... *Obelia geniculata.* *Obelia longissima.* *Obelia flabellata?*
     g. Tentacles 16 at liberation of medusa ..... *Obelia gelatinosa.* *Obelia dichotoma.* *Obelia commissuralis.*
   e'. Bell deeper, its surface evenly rounded.
    f. Otocysts between bases of tentacles.
     g. Otocysts 8 (or more?). Mouth tentacles not fimbriated ..... *Clytia bicophora.*
     g'. Otocysts 8. Mouth tentacles fimbriated ..... *Tiaropsis diademata.*
     g''. Otocysts numerous, with sense-bulbs at their bases ..... *Epentheses folleata.*
     g'''. Otocysts numerous. Tentacles with sense-bulbs and thickened "knee-pads" ..... *Gonionemus vertens.*
 c''. Bell with a distinct dome-like apical projection ..... *Oceania singularis.*
a'. Radial canals 8.
 b. Bell very deep, shaped like a bishop's miter ..... *Trachynema digitalis.*
 b'. Bell subspherical, somewhat narrowed above. Mouth with fringed tentacles ..... *Melicertum campanula.*
a''. Radial canals more than 8.
 b. Manubrium very short, hardly distinguishable ..... *Rhegmatodes tenuis.*
 b'. Manubrium well developed.
  c. Mouth without fimbriated tentacles. Bell shallow ..... *Æquorea albida.*
  c'. Mouth with fimbriated tentacles ..... *Zygodactyla grœnlandica.*

Euphysa virgulata A. Ag.

(North American Acalephæ, p. 189.)

Bell quadrangular, thick, longer than broad. Proboscis short, tubular, without mouth tentacles. Tentacles 4, of which one is much longer than the others and has a triangular base. Radial canals 4. Velum with a sinuous inner edge.

Coloration.—Tentacles with white bases and a pink stripe or band. Proboscis light yellow.

I have not seen this species, and the above description is condensed from that of Dr. Agassiz.

Hybocodon prolifer L. Ag. Fig. 76.

(Cont. Nat. Hist. U. S., vol. IV, p. 243.)

Bell ovate, evenly rounded, unsymmetrical owing to great development of the single tentacle; its surface marked with 5 meridional orange-colored bands, 2 of which start from the sides of the base of the tentacle. Proboscis long, contractile, sometimes reaching nearly to the velum; no mouth tentacles. A single very large marginal tentacle armed with conspicuous nematocyst batteries and bearing medusæ of a second generation at its base.

Color.—Superficial bands and base of tentacle orange red.

Distribution.—Taken in the tow at Woods Hole (Vinal Edwards.) The colored bands are not easily seen in these specimens, which were collected in April.

This species can at once be recognized by its single greatly developed tentacle with secondary medusæ at its base.

Corymorpha pendula L. Ag.

(Cont. Nat. Hist. U. S., p. 276. The medusa is described by A. Agassiz in North American Acalephæ, p. 192.)

Bell deep, with the apex somewhat pointed, slightly unsymmetrical owing to the excessive development of one tentacle. Proboscis long, often reaching below the velum. Tentacles 4, one being much the largest, but not bearing secondary medusæ at its base.

Color.—Proboscis light yellow; bases of tentacles light pink. (A. Agassiz.)

Distribution.—I find no record of this medusa having been found in the Woods Hole region, although the hydroid form from which it grows has been found there. Alexander Agassiz reports it from off Cape Cod.

Stomotoca apicata (McCrady). Fig. 77.

(*Saphenia apicata* McCr. Proc. Elliott Soc., vol. I, No. 1, p. 130.)

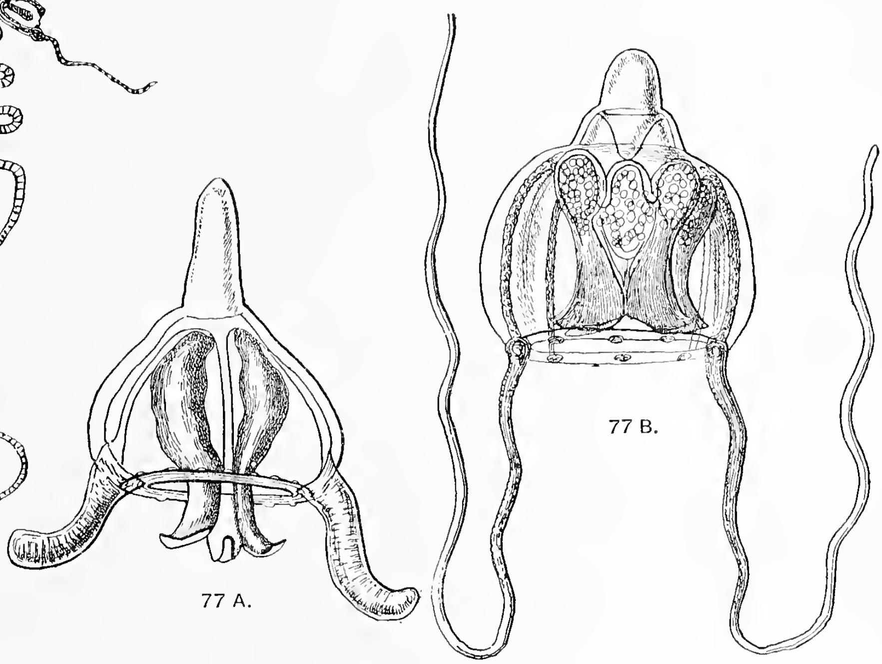
Male.—Bell broad and shallow, with a long conical projection at its summit. Marginal tentacles 2, very long, but capable of retracting into short, finger-like bodies as in the figure; rudiments of other tentacles around the margin. Proboscis very large and bulky, composed of lobes that extend to the 4 mouth tentacles, which are pointed and reach below the velum. Radial canals 4.

Colors.—Tentacles rich purple, tipped with olive green. Spermaries and basal part of proboscis clear light emerald green. These colors differ greatly from those given by McCrady. They are taken by myself from a living specimen.

Female (=*Dinamatella carosa* Fewkes).—Bell subglobular with a cone-shaped apical projection, the cone being shorter than in the male, and divided into two portions, a basal dome-shaped portion being surmounted by the short subconical apical part. Tentacles 2, hollow, very long; besides these there are 6 rudimentary tentacles on the bell margin which bear pigment spots at their bases. Proboscis very broad and heavy, reaching about to the velum, and bearing four heavy lips which are not fimbriated. Ovaries forming masses around the proximal part of the proboscis. Radial canals 4, band-like, with irregular jagged edges.

Colors.—General color light green. Ovaries yellowish white. Tentacles greenish. Pigment spots orange, with a bright red dot in the center.

Distribution.—Newport Harbor, August, 1896.



76. *Hybocodon prolifer* Ag.

77. *Stomotoca apicata* (McCr.). 77 A. Male. 77 B. Female.

Gemmaria cladophora A. Ag. Fig. 78.

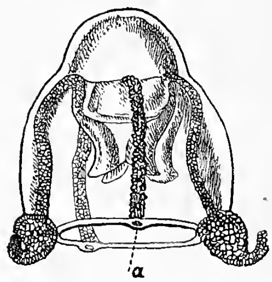
(North American Acalephæ, p. 184.)

Bell rather deep, the apical portion being elevated into a shallow rounded dome not sharply, but still evidently differentiated from the rest of the bell. Tentacles 4, two of which are much the longest and bear curious clusters of nematocysts borne on short stalks or pedicels. Proboscis scarcely reach-

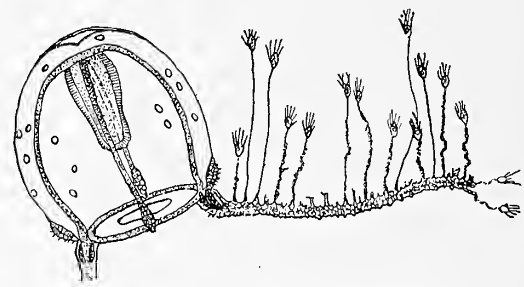
ing the bell opening, constricted just above the 4 small lips or mouth-arms, and bearing the ovaries on the proximal portion. Radial canals broad.

Colors.—The large tentacles light brown with a slight orange tinge at bases. There are bright yellow pigment spots at the bases of the two rudimentary tentacles.

Distribution.—Collected at Woods Hole, August, 1899.



78. *Gemmaria cladophora* A. Ag.



79. *Corynitis agassizii* (McCr.). (After Murbach.)

Corynitis agassizii (McCrady). Fig. 79.

(Proc. Elliott Soc., vol. I, No. 1, p. 132.)

Bell deep, orbicular, without apical prominence. Tentacles 2, very long, bearing stalked batteries of nematocysts. There are also two rudimentary tentacles. Proboscis short and simple, without expanded lips. Radial canals 4, not broad and bandlike, and with curious bulging groups of nematocysts on the outside of the bell over the distal portions of the canals.

Colors.—Not given either in the original description or that of Dr. L. Murbach, who first established the connection between *Corynitis agassizii* and *Gemmaria gemmosa* of McCrady, the latter being the medusa of the former. His figures are here copied by permission.

Distribution.—Woods Hole. (L. Murbach.)

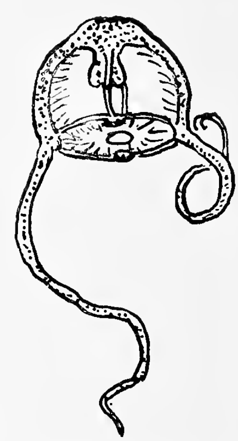
Perigonimus jonesii Osborn & Hargitt. Fig. 80.

(American Naturalist, 1894, p. 27.)

Bell orbicular, marginal tentacles 2, long and hollow, alternating with two eye-spots, which may indicate two rudimentary tentacles. Proboscis short, not reaching much more than half way to the broad and strong velum. Radial canals 4, those leading to the large tentacles broader than the others.

Colors.—Not given by the describers. The medusa buds, while still attached, are a light salmon color in specimens kindly furnished me by Dr. Hargitt.

Distribution.—Cold Spring Harbor, Long Island.



80. *Perigonimus jonesii* Osb. & Harg. (After Osborn & Hargitt.)

Syncoryne mirabilis Ag. Fig. 81.

(Cont. Nat. Hist. U. S., vol. IV, p. 185.)

Bell orbicular. Marginal tentacles 4, very long, each with a swollen pigmented body at its base. Proboscis very long, reaching far below the bell opening when fully extended, but capable of being retracted well within the bell, suspended from the bell by a narrow, contracted portion. Mouth a simple opening without mouth tentacles. The attached medusa is longer, the tentacles closely coiled, and the proboscis retracted within the bell and often having its walls distended with sexual products.

Colors.—Specimens in formalin have the proboscis and tentacle bulbs light yellowish. Eye-spots black.

Distribution.—Collected at Woods Hole by Mr. George Gray.

Dipurena conica A. Ag.

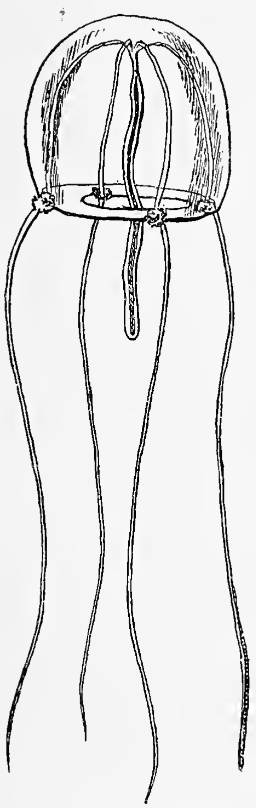
(North American Acalephæ, p. 181.)

Bell a rounded cone. Marginal tentacles 4, rather short, each with a rounded knob on the distal end and a pigmented spot and eye-speck at the base. Proboscis long, when fully extended reaching far below the rather broad velum, but capable of great retraction; attenuated proximally and swollen distally; mouth plain, without mouth tentacles. Radial canals 4, slender. Young specimens are almost globular in form.

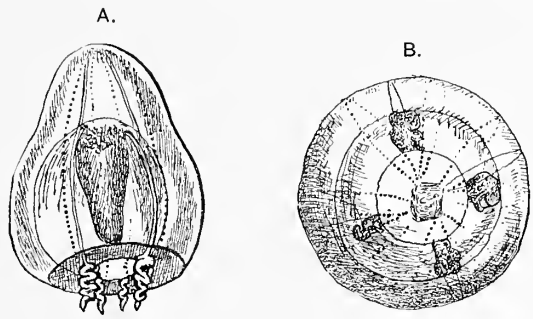
Colors.—Distal and proximal ends of tentacles reddish. Eye-specks black.

Distribution.—Naushon (A. Agassiz).

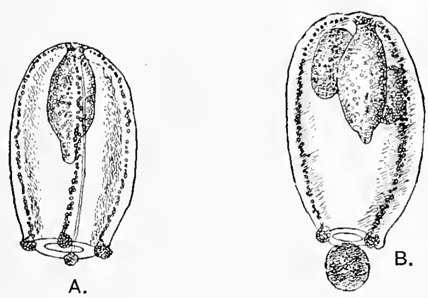
I have not seen this species; the above description is condensed from that of Dr. A. Agassiz.



81. *Syncoryne mirabilis* (Ag.)



82. *Ectopleura ochracea* A. Ag.
A. Lateral view. B. Aboral view.



83. *Pennaria tiarella* McCr.
A. Medusa from which the ova has been expelled.
B. Medusa expelling an ovum.

Ectopleura ochracea A. Ag. Fig. 82.

(L. Agassiz, Cont. Nat. Hist. U. S., vol. IV, p. 343.)

Bell longer than broad, subpyriform in shape, the upper end being the smaller; surface ornamented by eight meridional bands of nematocysts, a band originating on each side of each tentacle base and passing directly over the surface of the bell to its apex. Tentacles 4, short, usually carried so closely coiled as to appear like mere knobs. Proboscis terete, not reaching to the bell opening, and ending in a simple mouth. Radial canals 4.

Colors.—Manubrium bright yellow proximally and distally, the middle part being rose pink. Tentacular bulbs ochraceous, with a red eye-spot on each.

Distribution.—Abundant at Newport in August. Woods Hole. Probably common throughout the region discussed in this work.

Pennaria tiarella McCr. Fig. 83.
(Proc. Elliott Soc., vol. I, No. 1, p. 153.)

Bell very deep, regularly elliptical in outline. Marginal tentacles 4, rudimentary. Proboscis oblong ovoid, with both ends constricted, not reaching velum; mouth opening not apparent. Radial canals 4, accompanied with lines of dark pigment.

Colors.—Manubrium and lines over radial canals deep pink, the latter being darker and more brilliant.

Distribution.—Common in shallow water throughout the Woods Hole region, especially in the latter part of the summer. Growing profusely on the piles of the wharf at Woods Hole and on the eelgrass near by.

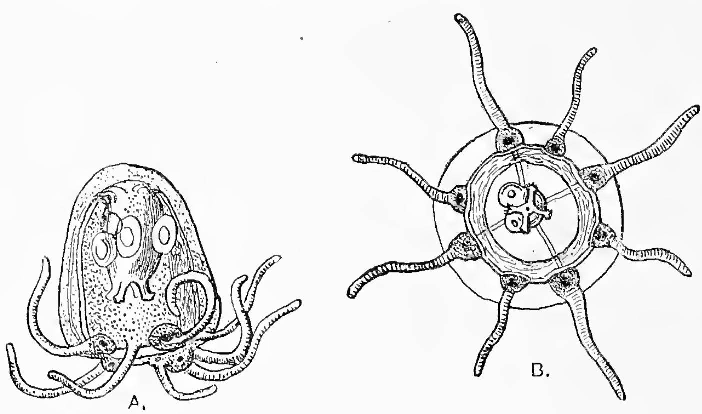
Hydrichthys mirus Fewkes.
(Bull. Mus. Comp. Zool., vol. XIII, No. 7, p. 224.)

Bell oval, nearly spherical, its surface dotted with nematocysts. Marginal tentacles 2, when first liberated, afterwards 4. Radial canals 4, very broad, bandlike. Proboscis cylindrical, not reaching the broad velum. The tentacular bulbs are without eye-spots.

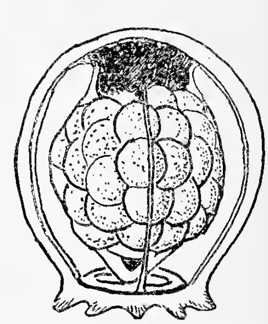
Colors.—Proboscis orange and yellow. Tentacular bulbs reddish.

Distribution.—The type specimens were liberated from a colony growing on a fish, *Seriola zonata*, which was brought into Dr. Alexander Agassiz's laboratory at Newport.

I have not seen this species, and the above description is condensed from that of the original describer.



84. *Dysmorphosa fulgurans* A. Ag. A. Lateral view. B. Ventral view.



85. *Stylactis hooperi* Sigerfoos (after Sigerfoos).

Dysmorphosa fulgurans A. Ag. Fig. 84.
(North American Acalephæ, p. 163.)

Bell ovoid, its surface having a granulated appearance. Marginal tentacles 8, rather stout, and held somewhat stiffly, each with a bulbous expansion with a distinct eye-spot at its base. Proboscis short, not reaching much more than half way to the bell opening and ending with four mouth tentacles furnished with terminal rounded batteries of nematocysts. Specimens secured in August had young medusæ growing on the upper part of the proboscis, and these themselves often show budding medusæ of still another generation. Radial canals 4.

Colors.—The pigment spots at the bases of the tentacles are bright orange red.

Distribution.—During the summer, throughout the Woods Hole region. Agassiz says in reference to this species that it is "sometimes so abundant that the whole sea, when disturbed, is brilliantly lighted by the peculiar bluish phosphorescent color which they give out."

Stylactis hooperi Sigerfoos. Fig. 85.
(American Naturalist, vol. XXXIII, No. 394, p. 801.)

Bell ovoid. Marginal tentacles 8, rudimentary. Proboscis very large and broad, not reaching beyond the bell opening, greatly distended with sexual products at time of liberation, without mouth tentacles or mouth. Eye-spots absent. Radial canals 4.

Colors.—Not given by the original describer. The color of the medusæ while still attached in specimens preserved in formalin is light salmon.

Found growing on a live gasteropod, *Ilyanassa*. Collected near Woods Hole by Mr. Waldron. Type from Cold Spring Harbor, L. I.

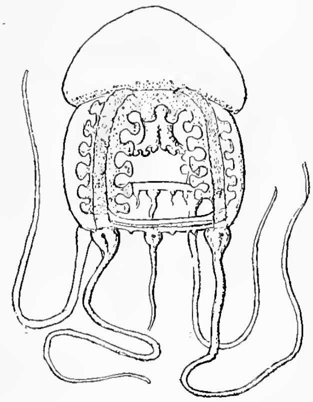
Turris vesicaria A. Ag. Fig. 86.

(North American Acalephæ, p. 164.)

Bell dome-shaped, surmounted by a subglobular or subconical body, which appears to be hollow. Tentacles numerous when full grown, but one good-sized specimen, apparently almost mature, has only 8. Each tentacle is dilated at the base into a tentacular bulb that bears an eye-spot. Proboscis short, ending in four frilled mouth arms. Ovaries, forming large complicated frills, extending down on either side of the radial canals and connecting at their proximal ends. Radial canals 4, broad and with transverse striæ and edges which appear jagged or frayed out.

Colors.—Ovaries and tentacular bulbs yellow.

Distribution.—Woods Hole, Mass. (Vinal Edwards).



86. *Turris vesicaria* A. Ag.

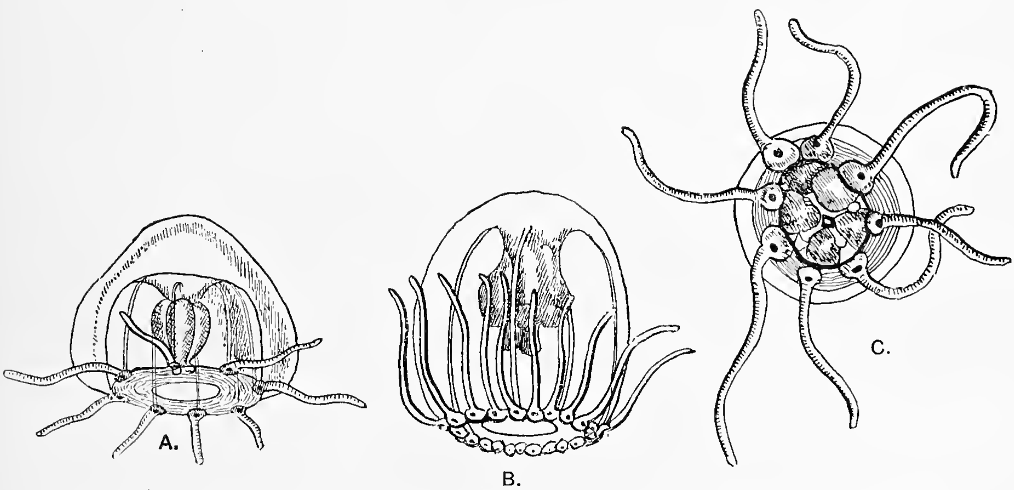
Turritopsis nutricula McCrady. Fig. 87.

(Proc. Elliott. Soc. vol. I, No. 1, p. 127.)

Bell hemispherical ovoid, or sub-conical. Marginal tentacles varying in number according to age, from 4 to 24 in specimens examined, and held somewhat stiffly, each with a tentacular bulb bearing an eye-spot at its base. Proboscis not reaching to the bell opening, and ending in four small mouth tentacles bearing distal clusters of nematocysts. The genital products are contained in four large oval masses around the proximal part of the proboscis and reach to the bases of the mouth-arms. Radial canals 4. Velum broad.

Colors.—Eye-spots red. Distal part of ovaries bright lemon yellow.

Distribution.—Naushon. (A. Agassiz.) Woods Hole, Massachusetts.



87. *Turritopsis nutricula* McCr.

A. Lateral view of young. B. Lateral view of older specimen. C. Ventral view of young.

Nemopsis bachei Ag. Fig. 88.

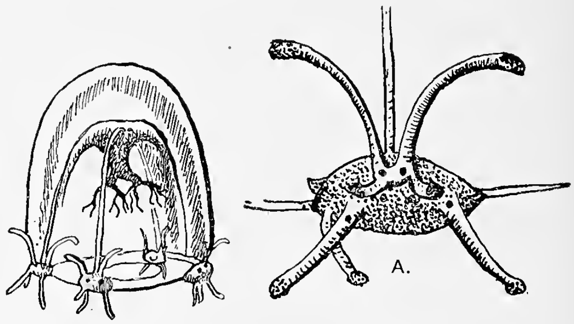
(Mem. Am. Acad. Sci., IV, p. 289.)

Bell deep, ovoid, sometimes almost globular; thickness of bell substance greater than in most of preceding species, making bell cavity proportionally small. Tentacles in 4 bunches, the middle pair in

each bunch being distinctly club-shaped at ends. Proboscis short and small, ending in 4 much-branched mouth-tentacles, each ramification of which ends in an oval group of nematocysts. Mouth-tentacles highly retractile and not evident when animal is disturbed. The bunches of marginal tentacles are borne on conspicuous swellings or pads at terminations of the four radial canals, and each tentacle has a black eye-spot above its base.

Colors.—Tentacular bulbs and ovaries yellow. Ends of middle tentacles of each bunch dark brown.

Distribution.—Nantucket and Naushon (A. Agassiz), Newport, Vineyard Sound, Buzzards Bay.



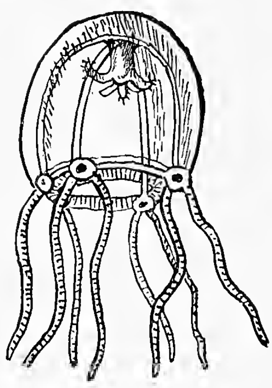
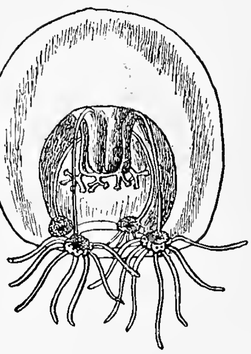
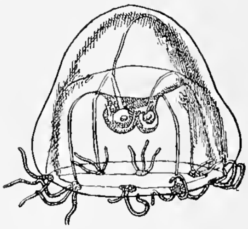
88. *Nemopsis bachei* L. Ag. (Juv.)
A. A sense-bulb and group of tentacles (enlarged).

Bougainvillia carolinensis (McCr.). Fig. 89.
(*Hippocrene carolinensis* McCr. Proc. Elliott Soc., vol. I, No. 1, p. 164.)

Bell subglobular, thick. Marginal tentacles in four bunches, arising from marginal swellings which are narrower and more pointed than in the preceding species. Tentacles all alike, with slightly enlarged ends, and eye-spots over their bases. Proboscis slender, with four branched mouth-tentacles ending in nematocyst batteries. Radial canals, 4.

Colors.—Tentacular bulbs red, edged with yellow. Proboscis red.

Distribution.—Common in the Woods Hole region.

89. *Bougainvillia carolinensis* (McCr.). (Juv.). 90. *Bougainvillia superciliaris* Ag. 91. *Lizzia grata* A. Ag.

Bougainvillia superciliaris Ag. Fig. 90.
(Cont. Nat. Hist. U. S., vol. IV, p. 289.)

Bell subglobular, very thick. Marginal tentacles in four pairs at birth, later in four bunches. Tentacular bulbs and eye-spots as in the preceding species. Proboscis thick and heavy but not reaching much more than half way to the bell opening, ending in four branched mouth-tentacles terminating in nematocyst batteries. Radial canals, 4.

Colors.—Marginal sense-bodies orange red surrounded by yellow. Proboscis pale yellow, tinged with red distally.

Distribution.—Newport, Rhode Island (Leidy). Woods Hole.

Lizzia grata A. Ag. Fig. 91.
(Proc. Boston Soc. Nat. Hist., p. 100.)

Bell deep, subconical in outline, lower portion noticeably wider than upper. Marginal tentacles in 8 clusters borne on marginal swellings, but without distinct eye-spots at base of each tentacle.

Proboscis rather large, capable of being protruded nearly to the bell opening, and ending in 4 mouth-tentacles which are branched, but not so extensively as in preceding species. Radial canals, 4.

Colors.—Marginal swellings deep orange brown.

Distribution.—Newport, Rhode Island.

Willia ornata McCr.

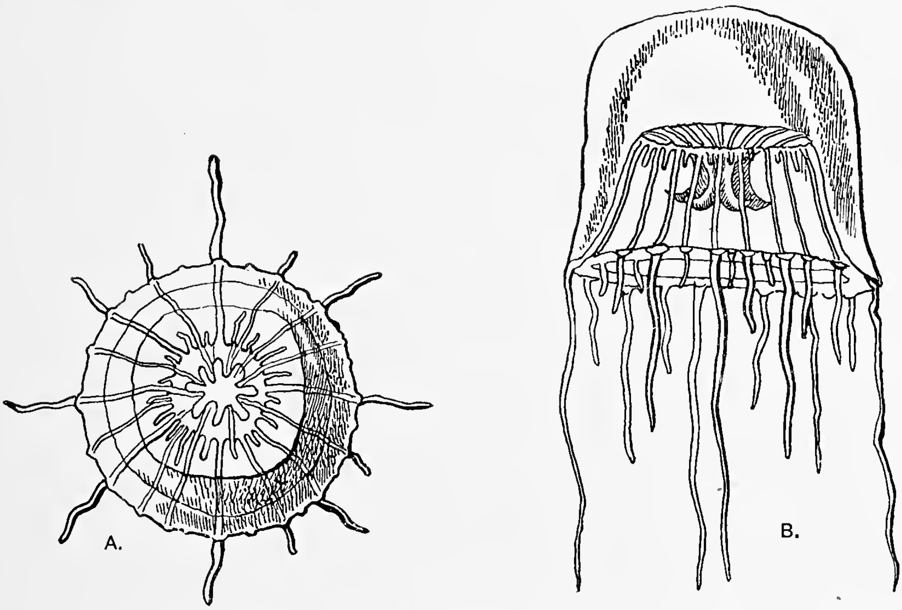
(Proc. Elliott Soc., vol. I, No. 1, p. 149.)

Bell subconical. Tentacles of adult 16, one to each branch of the radial canals. Proboscis short, ending in 4 lobular unbranched mouth-tentacles armed with nematocysts which are not aggregated into round batteries. Ovaries forming 4 masses around proximal part of proboscis. Radial canals 4, each divided distally into 4 branches. Between each pair of tentacles a superficial structure like a "knotted chord" passes upward on outside of bell. Sense-bulbs found at bases of tentacles.

Colors.—Not described by McCrady or Agassiz.

Distribution.—Buzzards Bay, Naushon. (A. Ag.)

I have not seen this species, and the above description is condensed from that of McCrady.



92. *Orchistoma tentaculata* Mayer. A. Aboral view. B. Lateral view.

Orchistoma tentaculata Mayer. Fig. 92.

(Bull. Mus. Comp. Zool., vol. XXXVII, No. 1, p. 3.)

Bell deep, cup-shaped, its substance very thick in upper portion much reducing depth of bell cavity. Marginal tentacles 32, with sense-bulbs at their bases. No otocysts. Proboscis short, with 4 lobulated mouth-arms, the lobes margined with nematocyst-bearing tentacles. Radial canals 16, alternating with 16 short tubes given off from near top of bell cavity. Ovaries borne on proboscis.

Colors.—Proboscis and sense-bulbs red.

Distribution.—Newport, Rhode Island.

Eutima limpida A. Ag.

(North American Acalephæ, p. 116.)

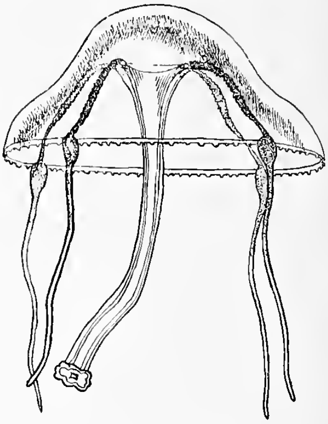
Like *E. mira* with the following exceptions: Bases of the four tentacles not swollen, and each provided with two lateral cirri. The ovaries, tentacles, and proboscis almost colorless.

Distribution.—Buzzards Bay; Naushon. (A. Ag.)

Eutima mira McCr. Fig. 93.

(Proc. Elliott Soc., vol. I, No. 1, p. 190.)

Bell broad, subconical, the lateral profile sinuous, upper part dome-shaped. Tentacles 4, with swollen sense-bodies at bases, but without lateral cirri. Otocysts 8, two between each two radial canals, conspicuous, containing highly refractile granules. A number of rudimentary tentacles around the bell margin. Proboscis very long, extending below the bell two or three times the depth of the latter, and ending in a mouth surrounded by a disk-like lobed frill. Ovaries disposed along the radial canals.



93. *Eutima mira* McCr.

Colors.—Swollen tentacular bases a bright light green. Ovaries whitish. Proboscis not noticeably colored.

Distribution.—Woods Hole, Massachusetts. August 10, 1899.

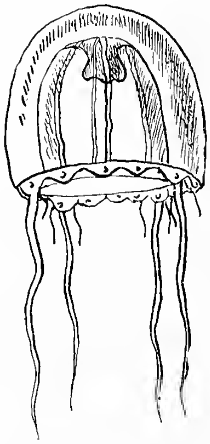
Hebella calcarata (A. Ag.) = *Dynamena cornicina* McCr. (in part). Fig. 94.

(*Laodicea calcarata* Ag., Cont. Nat. Hist. U. S., p. 350.)

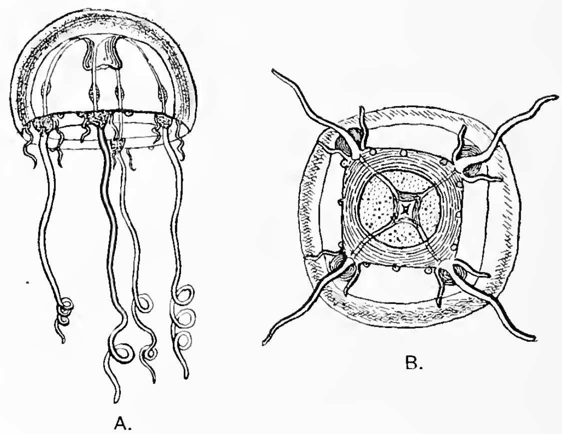
Bell of adult rather shallow, bowl-shaped, young almost spherical, with the outline of the sides rather sinuous. Marginal tentacles rather numerous, hollow, with sense-bulbs at their bases and a spur-like projection extending inward from the base of each. Other tentacles have no sense-bulbs and are much more slender, appearing like lateral cirri in young specimens; still other tentacles are short and clavate. Proboscis very short, ending in four frilled mouth-arms. Ovaries in form of convoluted bands along the four radial canals.

Colors.—Ovaries and larger tentacles dark yellowish. Eye-spots dark violet. (A. Ag.)

Distribution.—Vineyard Sound (Verrill); Newport and Woods Hole. Naushon. (A. Ag.)



94. *Hebella calcarata* (Ag.).



95. *Eucheilota duodecimalis* A. Ag. A. Lateral view. B. Oral view.

Eucheilota duodecimalis A. Ag. Fig. 95.

(Cont. Nat. Hist. U. S., IV, p. 353.)

Bell hemispherical or subglobular. Marginal tentacles 4, each with a sense-bulb and two lateral cirri at its base. Three otocysts between each two tentacles, making twelve in all. Proboscis very short, tubular, with inconspicuous lips. Ovaries along radial canals, very conspicuous when mature. Radial canals 4. Velum broad.

Colors.—Spots on sense-bulbs straw-yellow.

Distribution.—Buzzards Bay (A. Ag.); Newport; Woods Hole.

Eucheilota ventricularis McCr.

(Proc. Elliott Soc., vol. I, No. 1, p. 187.)

Bell hemispherical. Tentacles 16 to 20, with sense-bulbs at bases, highly contractile. Otocysts 8, with refractile granules arranged in an arc. Proboscis short, tubular, not reaching to bell opening. Radial canals 4, wide. Ovaries occupying whole length of radial tubes. Velum wide.

Colors.—Proboscis yellow, with a red central portion. Ovaries yellow, sense-bulbs with a red center.

Distribution.—Naushon; Buzzards Bay (A. Ag.).

This description is condensed from that of McCrady. Dr. Agassiz appears to doubt whether his species is the same as that of McCrady, and describes it as having lateral cirri to the tentacles. I have not seen this species.

Clytia noliformis (McCr.).

(*Campanularia noliformis* McCr., Proc. Elliott Soc., vol. I, No. 1, p. 194.)

Bell hemispherical. Marginal tentacles 4 in young and more numerous in adults. Otocysts 8, two between each two radial canals; always between tentacle bases, and not on them. No eye-spots. Proboscis very short, ending in a four-lobed mouth. Radial canals 4.

Colors.—There are no conspicuous colors. Ovaries yellowish-white.

Distribution.—Buzzards Bay and Naushon (A. Agassiz, under name of *Platypyxis cylindrica*).

Clytia bicophora Ag.

(Cont. Nat. Hist. U. S., vol. IV, p. 304.)

Bell hemispherical, considerably flattened in older specimens. Tentacles 4 to 16, according to age. Otocysts 8 or 16, according to age, placed between tentacular bases. Proboscis short, ending in a 4-lobed mouth. Ovaries, in adult, reaching along radial canals nearly to proboscis. Radial canals 4.

Colors.—Ovaries brown. Black spots on swollen bases of tentacles.

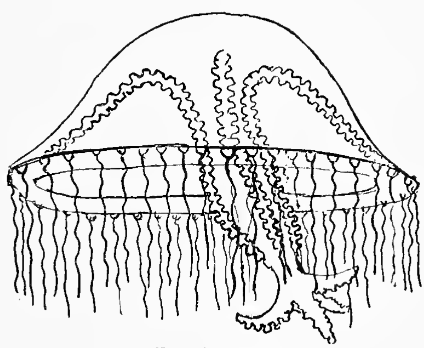
Distribution.—Naushon; Vineyard Sound (A. Ag.).

I have not seen this species, and the above description is condensed from that given by Dr. A. Agassiz, North American Acalephæ, p. 78.

Tima formosa Ag. Fig. 96.

(Cont. Nat. Hist. U. S., vol. IV, p. 362.)

Bell broadly campanulate, the edges perceptibly flaring, the lateral outline sinuous. Marginal tentacles 32, some of which are often rudimentary, with swollen sense-bulbs at their bases. Otocysts numerous, placed between the bases of the tentacles, each with a few granules near its margin. Proboscis very long, in the shape of a very attenuate cone with its base upward, and extending far beyond the bell opening when expanded. Mouth surrounded by four conspicuous frilled lappets. Ovaries strongly convoluted and extending the full length of radial canals and proboscis. Radial canals 4. Size very large. Among the largest of our hydroid medusæ.



96. *Tima formosa* Ag.

Colors.—Ovaries and sense-bulbs whitish; sometimes light-yellowish.

Distribution.—Woods Hole (F. M. Walmsley); Vineyard Sound (Verrill).

Obelia longissima (Pallas).

(*Sertularia longissima* Pallas, Elenchus Zoophytorum, p. 119.)

It is exceedingly difficult, if not impossible, to differentiate the medusæ of the various species of this genus. In some cases the only way to identify them is to see them given off from the hydroid

colonies. I know of no means of distinguishing this species from the preceding except that the tentacles may be 20 instead of 24.

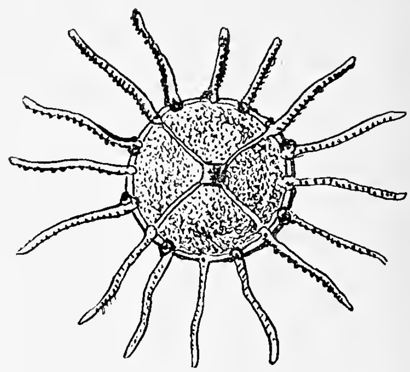
Distribution.—The hydroid colonies have been found at Woods Hole and off Gay Head.

Obelia flabellata (Hincks)[1]=*Eucope polygena* A. Ag.?[2]

([1] Ann. and Mag. Nat. Hist., 3d series, vol. XVIII, p. 297. [2] North American Acalephæ, p. 86.)

Differs from the preceding in no constant feature that I am aware of.

Distribution.—Woods Hole; off Thimble Island (Verrill).



97. *Obelia commissuralis* McCr.

Obelia commissuralis McCr. Fig. 97.

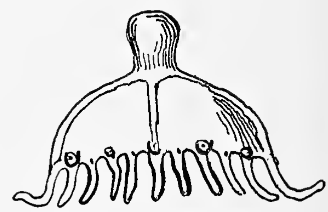
(Proc. Elliott Soc., vol. I, No. 1, p. 197.)

Bell disk-shaped. Marginal tentacles 16 at time of liberation, long and slender. Ovaries not developed at time of liberation.

Distribution.—Colonies abundant in Woods Hole region, growing on piling of wharves and on submerged timbers generally.

Obelia geniculata (Linn.). Figs. 39A, 98.

(*Sertularia geniculata* Linn., Syst. Nat., p. 1312.)



98. *Obelia geniculata* (Linn.).

Bell disk-shaped, or shallow bowl-shaped. Marginal tentacles 24 at birth, each with an inward projecting spur. Otocysts 8, two between each two radial canals, placed over the bases of the tentacles and not between them. Proboscis short, with four inconspicuous lobular lips. Radial canals 4. Ovaries oval, hanging beneath the middle portion of the radial canals. No sense-bulbs. This, like other species of *Obelia*, has the habit of swimming with the bell reversed, so that it appears somewhat like an umbrella turned wrong side out.

Colors.—The only color is in the light-yellowish ovaries and proboscis.

Distribution.—Abundant throughout Woods Hole region.

Obelia gelatinosa (Pallas)[1]=*Laomedea gigantea* A. Ag.[2] (Verrill).

([1] *Sertularia gelatinosa* Pallas, Elenchus Zoophytorum, p. 116. [2] North American Acalephæ, p. 94.)

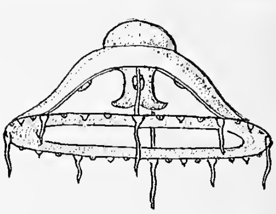
Bell disk-shaped. Tentacles 16 at time of liberation, each with an inward-projecting spur. Otocysts 8, placed over bases of tentacles. Proboscis short, with mouth surrounded by four lobular lips or mouth-arms. Radial canals 4. Ovaries round, hanging beneath middle part of radial canals.

Colors.—Ovaries and proboscis light-yellowish.

Distribution.—Colonies have been found growing at New Haven, Conn.; along the Rhode Island coast, and in Vineyard Sound.

Obelia dichotoma (Linn.).

(*Sertularia dichotoma* Linn., Syst. Nat., p. 1312.)



99. *Oceania singularis* Mayer.

Bell very shallow, disk-shaped. Marginal tentacles 16 at time of liberation. Not distinguishable from the preceding.

Distribution.—Colonies dredged off Gay Head, 1 fathom (Verrill).

Oceania singularis Mayer. Fig. 99.

(Bull. Mus. Comp. Zool., vol. XXXVIII, No. 1, p. 7.)

Bell rather shallow, flaring decidedly at margin, and with a well marked dome-shaped apical projection. Marginal tentacles 16, each bearing a sense-bulb at its base. There are rudimentary tentacles between bases of larger ones. Proboscis not extending beyond velum, and ending in four broad lobes or mouth-arms that are not fimbriated. Radial canals 4, bearing the ovaries on their upper portion. There is an otocyst between each pair of tentacles, including the rudimentary ones.

Colors.—"The entoderm of the proximal part of each tentacle bulb is turquoise-green, and the distal part is brownish-red. The entoderm of the proboscis and of the radial tubes in the neighborhood of the gonads is of a delicate turquoise tinge." (*Mayer.*)

Distribution.—Newport, Rhode Island. Dr. Mayer kindly allowed me to sketch the type.

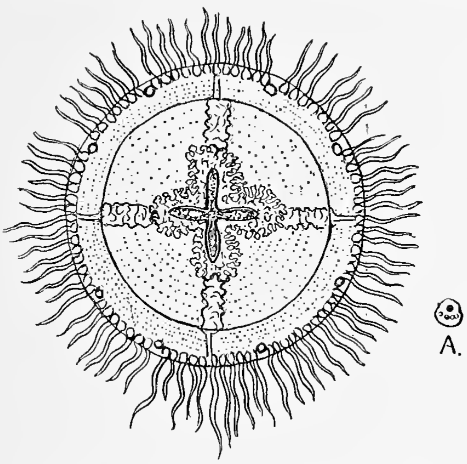
Tiaropsis diademata Ag. Fig. 100.

(Memoirs Amer. Acad., vol. IV, p. 289.)

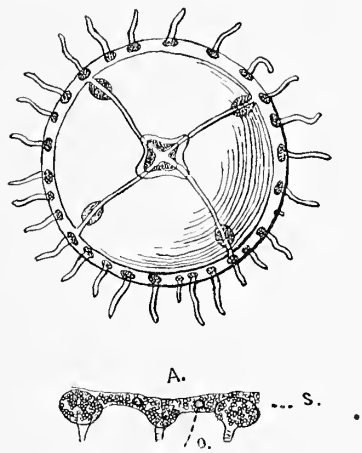
Bell hemispherical in adult, ovoid in young. Marginal tentacles numerous, with swollen sense-bulbs at the bases of the larger ones. Otocysts 8, situated between the bases of the tentacles and each containing a central dark dot with an arched row of refractile granules. Proboscis short, not reaching much more than half way to the velum and ending in four conspicuous, extensively frilled or fimbriated oral arms. Radial canals 4. Ovaries long, extending nearly to the circular canal.

Colors.—Specimens in formalin have the ovaries, oral arms, and tentacle bases light green.

Distribution.—Woods Hole, Mass. (Collected by Mr. Vinal Edwards.)



100. *Tiaropsis diademata* Ag. A. Otocyst (enlarged).



101. *Epenthesis folleata* McCr.
A. Details of margin. o. Otocyst. s. Sense bulb.

Epenthesis folleata McCr. Fig. 101.

(Proc. Elliott Soc., vol. I, No. 1, p. 191.)

Bell hemispherical, with thin walls. Marginal tentacles numerous, with sense-bulbs at bases. Otocysts alternating with tentacle bases. Proboscis short, ending in 4 lobular mouth-arms. Ovaries 4, round, hanging from under radial canals nearer to margin than to proboscis. Radial canals 4.

Colors.—Proboscis light green. Tentacular bulbs red.

Distribution.—Newport, Rhode Island.

Trachynema digitale A. Ag. Fig. 102.

(North American Acalephæ, p. 57.)

Bell very deep, with an outline something like that of a bishop's miter, somewhat pointed above. Marginal tentacles numerous, but most of them are usually lacking in preserved specimens. Otocysts 4, according to Agassiz, but they seem to be lacking in the specimens (males) that I have examined. Proboscis long, reaching nearly to the velum, ending in a constricted portion bearing the mouth surrounded by four lobular or finger-like mouth-arms. Radial canals 8. Ovaries 8, long "sausage-like" organs, reaching sometimes half way from the upper part of the bell cavity to the velum. Velum wide, strong, extensively wrinkled.

Colors.—Bell slightly pinkish. Contracted tentacles crimson at their extremity. Ovaries milky. Otocysts garnet-colored. (A. Agassiz.)

Distribution.—Newport, Rhode Island. Woods Hole. (Vinal Edwards.)

Gonionemus vertens A. Ag. Fig. 103.

(Cont. Nat. Hist. U. S., IV, p. 350.)

Bell hemispherical. Marginal tentacles numerous, each with a sense-bulb at its base and a "knee-pad" of adhesive cells near its end, which appears as a thickening of the tentacle. Otocysts numerous between the bases of the tentacles. Proboscis short, not reaching more than half way to the velum, and ending in four frilled mouth-arms. Radial canals, 4. Ovaries 4, forming convoluted bands following the radial canals to the bell margin.

Colors.—Tentacle bases emerald green and brown, with a black eye-spot. Proboscis and ovaries yellowish brown.

Distribution.—The Eel Pond, at Woods Hole.

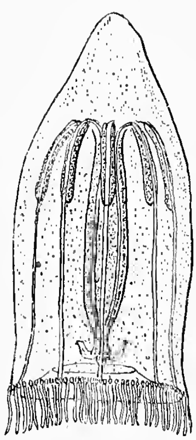
Melicertum campanula Esch. Fig. 104.

(Syst. der Acal., p. 105.)

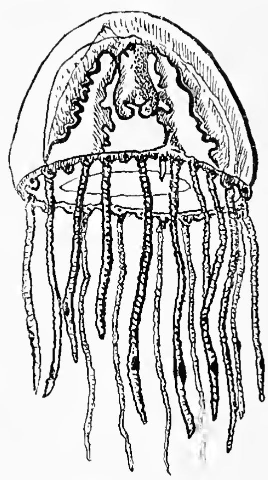
Bell deep, the upper portion somewhat narrowed. Marginal tentacles numerous, hollow, without eye-spots at their bases. No otocysts. Proboscis short, ending in eight frilled mouth-arms. Radial canals 8. Ovaries 8, convoluted, extending beneath the radial canals to the margin.

Colors.—Ovaries, proboscis, and tentacle bases light yellow.

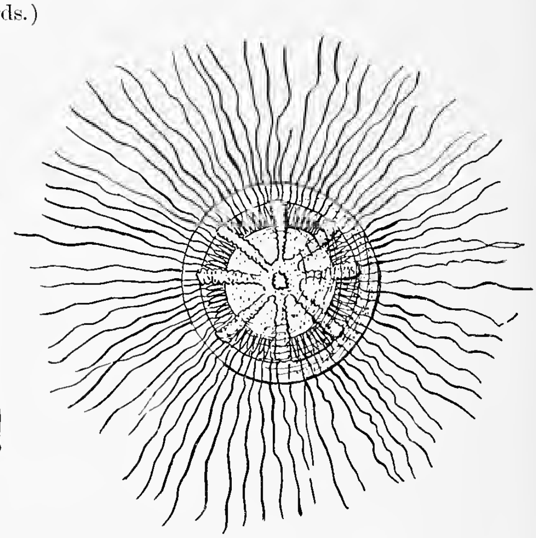
Distribution.—Woods Hole. (Vinal Edwards.)



102. *Trachynema digitale* (Fabr.).



103. *Gonionemus vertens* A. Ag.



104. *Melicertum campanula* Esch.

Æquorea albida A. Ag.

(North American Acalephæ, p. 110.)

Bell rather shallow, in the shape of a low dome with lateral outlines slightly sinuous. Marginal tentacles very numerous, with otocysts between their bases and without evident sense-bulbs. Proboscis small, but evident, without mouth-arms. Radial canals very numerous.

Colors.—Radial canals appearing as whitish lines.

Distribution.—Buzzards Bay; Naushon. (A. Agassiz.)

I have not seen this species, and the above description is taken from that of the original describer.[1]

Zygodactyla grœnlandica Ag.

(Cont. Nat. Hist. U. S., vol. IV, p. 360.)

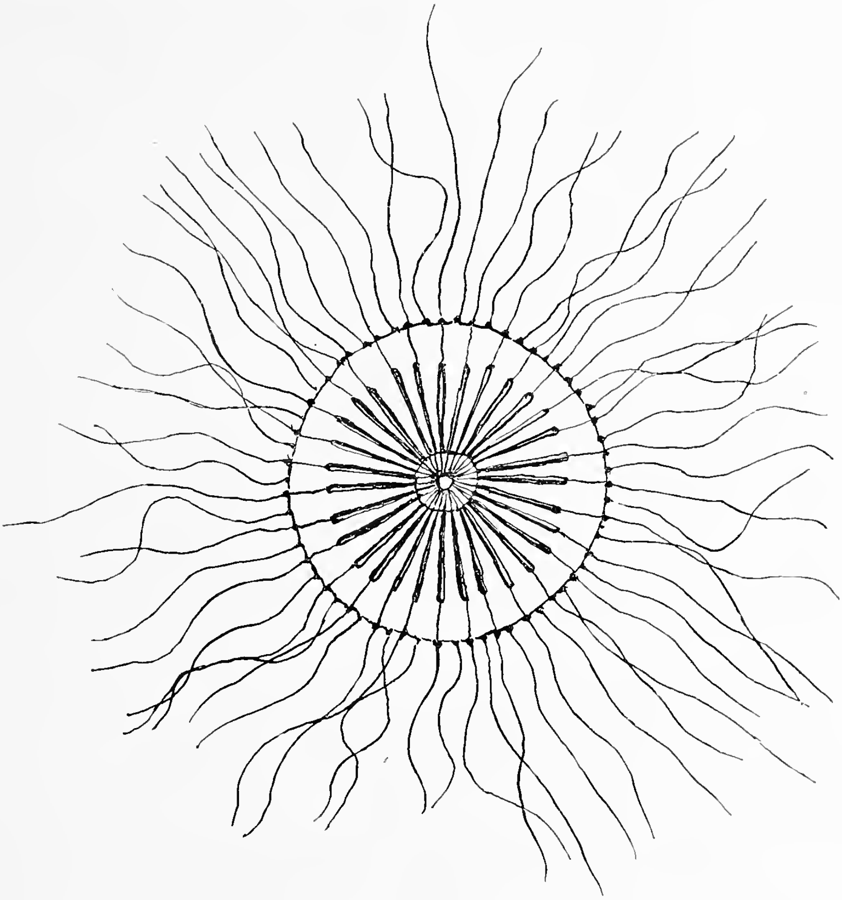
Bell shallow, a low dome, hardly emarginate along the lateral outlines. Marginal tentacles exceedingly numerous, swollen at their bases. Otocysts numerous; situated between the tentacle bases. Proboscis large, thin-walled, reaching beyond the bell opening when not retracted, and sur-

[1] Since the above was written numerous specimens of this species have been secured at Woods Hole by Mr. Hal. Childs.

rounded by extensively frilled or fimbriated mouth-arms. Radial canals and ovaries exceedingly numerous, the latter extending almost to the margin. Size very large.

Colors.—Not given by the original describer.

I have not seen this species, and condense the description from that of Dr. A. Agassiz.

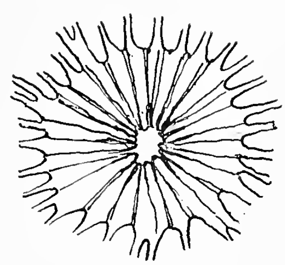


105. *Rhegmatodes tenuis* A. Ag.

Rhegmatodes tenuis A. Ag. Fig. 105.

(North American Acalephæ, p. 95.)

Bell very shallow, disk-shaped, with a central elevated portion. Tentacles very numerous, slender. Otocysts numerous, situated between the tentacle bases. There is practically no proboscis, but an irregular aperture under the center of the bell surrounded by an irregularly striated membrane which forms the floor of the digestive cavity. Radial canals numerous, there being about 32 in specimen examined. Ovaries linear, numerous, reaching along the radial canals from the digestive cavity nearly to the margin of the bell.



105 A. Oral view of center of disk

Colors.—There is very little coloration about this species. The ovaries are pale yellowish or brownish.

Distribution.—Naushon (A. Agassiz). Woods Hole.

GLOSSARY OF TECHNICAL TERMS USED IN THE HANDBOOK.

Acrocyst, an external, sac-shaped receptacle which rests on the top of the gonangium of certain species, and within which the generative products pass through the later stages of development.

Actinule, a peculiar hydranth-like body which is found in the female gonophores of many tubularian hydroids. After being expelled from the gonophore it leads a free life for a while, and then settles down, becomes attached by its aboral end, and grows into a new colony.

Bell, the gelatinous mass which forms the greater part of a medusa and is often called the "umbrella."

Blastostyle, a stem-like structure from which gonophores grow.

Cœnosarc, the living cellular tissue within the perisarc. It is composed of an outer layer called the ectoderm, an inner layer called the endoderm, separated by a structureless membrane called the mesoglœa.

Corbula, the pod-shaped receptacle for the gonangia in certain genera of the *Plumularidæ*.

Eye-speck or Eye-spot. See *sense-bulb*.

Fascicled stem, a stem which appears to be compound, or composed of a number of simple stems or tubes closely aggregated and often twisted together.

Gonangium, the chitinous receptacle for accommodation of the gonophores of the calypteroblastic hydroids.

Gonophore, the reproductive "person" of the colony which produces the generative products. It is usually destitute of a mouth and tentacles.

Gonosome, the assemblage of structures directly associated with sexual reproduction. It includes the gonophores, blastostyles, ovaries, gonangia, medusæ, etc.

Hydranth, a nutritive "person" of a colony consisting ordinarily of a body containing a digestive cavity surmounted by a proboscis which terminates in the mouth and is surrounded by radially disposed tentacles. A hydroid "polyp."

Hydrocaulus, the supporting framework of the colony, including the stem, branches, pedicels, etc.

Hydrocladium, the branches which bear the hydranths in the *Plumularidæ*.

Hydrophore, the collar-like expansion of the pedicel at the base of the hydranth of the *Halecidæ*. The expanded margin is often several times reduplicated. It is supposed to be a reduced hydrotheca.

Hydrorhiza, the root-like structure by which the hydroid colony is attached to stones, shells, or other bodies.

Hydrotheca, the chitinous receptacle into which the hydranths of the calypteroblastic hydroids retract. It is usually transparent, and consists of an expansion and extension of the perisarc of the pedicel.

Lithocyst, a usually glassy appearing body placed on the margin of the medusa bell and containing refractive granules. It is supposed to be sensory in function and to be used as either an organ of orientation or of hearing.

Manubrium, the proboscis of the medusa.

Marsupium, or Marsupial chamber, an internal chamber found within the gonangium of the genus *Diphasia*, in which the generative products pass through the later changes in their development.

Medusa, the free-swimming "jelly-fish" often given off from the hydroid colony. It usually bears, and serves to distribute, the generative products. A "sessile" medusa is one that remains attached to the parent stem after the generative products are expelled.

Nematocyst, a "nettling cell," or "urticating cell," consisting of an outer sac containing a barbed thread, which can be rapidly projected with such force as to penetrate the tissues of the prey or enemy and inject an irritant poison.

Nematophore, a chitinous receptacle for the defensive "person" or sarcostyle of the *Plumularidæ*. It is much smaller than the hydrotheca, but bears the same relation to the sarcostyle that the hydrotheca does to the hydranth.

Operculum, a movable lid or cover which closes the aperture of the hydrotheca in many calypteroblastic hydroids. It consists of one or several pieces which are raised when the hydranth is expanded and lowered when it is retracted. In many cases the gonangia are also provided with opercula.

Otocyst. See *Lithocyst*.

Otolith, a highly refractile granule, one or several of which are found in the otocyst.

Ovaries, the generative organs of the medusæ. The term is often applied to both sexes. They are situated either on the proboscis, along (under) the radial canals, or in both places.

Pedicel, the stem or stalk that supports the hydranth and hydrotheca.

Perisarc, an external chitinous skeleton which invests and gives support to the stems, branches, etc., of most hydroids.

Planula, a free-swimming, usually pear-shaped ciliated body into which the ovum immediately develops in the course of the hydroid life cycle.

Proboscis, the portion of the hydranth body that usually surmounts the basal tentacles and contains the mouth, or the pendant mass which hangs like the clapper of a bell from the center of the bell cavity of a medusa. It is often called the manubrium.

Radial canals, tubes which are found on the under side of the umbrella of a medusa and lead from the digestive cavity to the circular canal around the bell margin.

Sarcostyle, the highly extensible defensive "person" found in the *Plumularidæ*. It contains nematocysts or adhesive cells or both, and is made up of ectoderm, mesoglœa, and endoderm. In some cases a body cavity has been demonstrated, but neither mouth nor tentacles.

Sense-bulb, a swelling, usually at the base of a marginal tentacle of a medusa, which is supposed to be sensory in function and often contains conspicuous pigment spots known as "eye-specks" or "eye-spots," supposed to have to do with the function of sight.

Septum, a horizontal partition which partly divides the cavity of the hydrotheca from that of the pedicel.

Spiral zooid, a peculiar defensive "person," found in *Hydractinia*, which is long and without a mouth, but capable of bending itself in a twist or spiral.

Sporosac, a sac-like gonophore without evident medusoid structure.

Tentacles, the slender, motile organs which are arranged usually in a radiate manner around the proboscis of the hydranth. They are "filiform" when without rounded distal knobs, and "capitate" when they are knobbed at the ends. In the medusa the "marginal tentacles" surround the bell margin and the "mouth tentacles" surround the mouth.

Trophosome, the entire assemblage of structures in the colony, except those directly associated with the reproductive parts. It includes the hydrocaulus, hydrorhiza, hydranths, etc.

Velum, a delicate membrane which is stretched across the bell opening of a hydroid medusa. It is attached to the bell margin and has a large circular opening in its center.

SYSTEMATIC INDEX.[1]

[1] No synonyms are included in this index.

DESCRIPTIONS OF FIFTEEN NEW SPECIES OF FISHES FROM THE HAWAIIAN ISLANDS.

By OLIVER P. JENKINS,
Professor of Physiology, Leland Stanford Junior University.

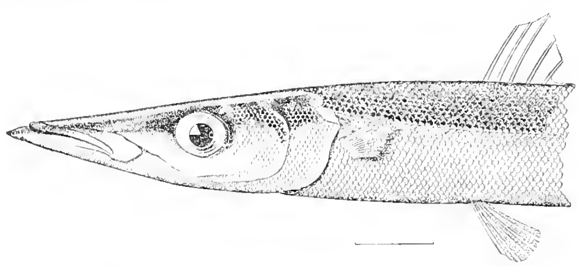
The fishes herein described are from the collections designated in a former paper by the writer in the U. S. Fish Commission Bulletin for 1899, pp. 45–65: "Descriptions of new species of fishes from the Hawaiian Islands, belonging to the families of *Labridæ* and *Scaridæ*." The species in the following list belong to the families *Sphyrænidæ*, *Serranidæ*, *Lutianidæ*, *Pomacentridæ*, *Chætodontidæ*, *Ostraciidæ*, *Tetraodontidæ*, *Tropidichthyidæ*, *Scorpænidæ*, *Percophidæ*, and *Brotulidæ*.

In the tables of measurements the numbers in decimals represent parts in length to base of caudal.

Family SPHYRÆNIDÆ.

Sphyræna helleri Jenkins, new species. Fig. 1.

Head a little greater than 3 in length of body; depth 8.5 in length. D. v, 10; A. 10. Head long and tapering, the snout being long, and the lower jaw, which projects beyond the upper, terminating in a tapering fleshy appendage. Eye 4.5 in head, slightly ovate, wider end anterior. Interorbital flat, 3.33 in snout, somewhat narrower than vertical diameter of eye. The maxillary does not reach front of orbit, being separated from it by a distance equal to about one-fifth of its own length. Scales on suborbital not extending forward beyond posterior border of eye. Scales on cheeks in about 12 vertical series, about 9 vertical rows on opercle, a few scales on suboperele, rest of head naked. Opercle without spines. Two teeth in front of lower jaw, about fifteen back of these in each ramus. Distance from occiput to first dorsal fin, from first dorsal to second dorsal, from second dorsal to last vertebra equal, and each equal to distance from tip of snout to posterior margin of eye. Insertion of ventrals below front of first dorsal fin, back of tips of pectorals. Front of anal opposite front of second dorsal. (Fin rays all broken in specimen described, pectoral apparently very short, perhaps 11 in length of body.)



1. *Sphyræna helleri* Jenkins, new species. Type.

Color in life: Upper parts plumbeous, lower parts silvery; top of head and fleshy tip of lower jaw blackish; fins plain.

This species is structurally very similar to *Sphyræna jello* Cuvier & Valenciennes,[1] of the Indian

[1] *Sphyræna jello* Cuvier & Valenciennes, Hist. Nat. Poiss., III, p. 349; Günther, Cat. Fishes Brit. Mus., II, p. 337.

Ocean, differing from that species in being of a uniform plumbeous color above and silvery below, with no undulating line on the side, such as is characteristic of *S. jello*. Cuvier & Valenciennes describe the color of *S. jello* thus: "The black of the back and the silvery color of the ventral surface are separated by a festooned or serpentine line on the side of the body close to the lateral line." *S. helleri* is related also, perhaps, to *S. idiastes* Snodgrass & Heller,[1] of the Galapagos Islands, differing from this species in the smaller number of scales on the opercles and body.

This species is named for Mr. Edmund Heller, who, with Mr. Robert E. Snodgrass, has made valuable contributions to the knowledge of the fishes of the Galapagos Islands.

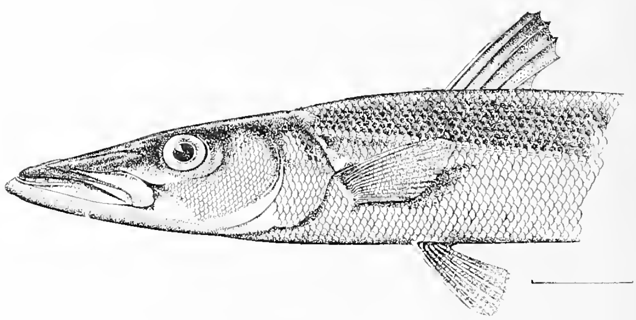
One specimen collected by me at Honolulu. Type No. 49692, U. S. National Museum.

The following gives the measurements and the numbers of fin rays and scales of the specimen:

Sphyræna helleri.	No. 1.	Sphyræna helleri.	No. 1.
Length in millimeters	330	Interorbital	.045
Head in length	.31	Distance between dorsals	.20
Depth	.12	Dorsal spines	V
Pectoral	.09(?)	Second dorsal rays	10
Ventral	.07(?)	Anal rays	10
Eye	.07	Scales (longitudinal)	123
Snout	.13	Scales (transverse)	12–15

Sphyræna snodgrassi Jenkins, new species. Fig. 2.

Head 3.25 in length of body; depth 6 in length. D. v, 10; A. 9. Shape of head and body regularly fusiform. Lower jaw projecting beyond upper a distance a little less than diameter of pupil; tip simply bluntly conical, not terminated by fleshy appendage. Eye somewhat ovate, larger end anterior, longitudinal diameter 4.75 in head. Interorbital space slightly concave, about equal to vertical diameter of eye. Maxillary reaches to front of eye. Suborbital scaled, 15 vertical rows of scales from eye to edge of preopercle, 10 rows on opercle, those of opercle enlarged; rest of head naked. Opercle without spines. (Some specimens have one or even two very weakly developed flat points on the opercle.) Upper jaw with two slender elongate teeth anteriorly on each side, along sides of jaw a single series of very small teeth. Lower jaw with two large anterior median teeth, and back of them a series of fifteen small ones in each ramus. Palatines and pterygoids with a long series of teeth, those of the palatines long and slender like those in the front of the jaws. Distance from occiput to front of first dorsal equal to distance from first dorsal to second dorsal, and to distance from second dorsal to base of caudal rays, which distance is 1.66 in head. Dorsal rays v, 10. First and second dorsal spines longest, 3 in head; fifth spine a little more than half of first. Second, third, and fourth rays of second dorsal longest, one-half longer than first spine. Anal rays 9. Anal fin very slightly behind soft dorsal, of same shape and size. Caudal deeply forked, lobes equal, longest rays 1.5 in head. Pectoral 8.5 in length. Ventral 9.5 in length. Lateral line slightly decurved on body before second dorsal, posterior part straight.



2. *Sphyræna snodgrassi* Jenkins. Type.

Color in life: Above lateral line plumbeous, below silvery, top of head blackish; a large dusky blotch on middle rays of second dorsal and of anal; tips of second dorsal and of caudal white; other parts of caudal dusky.

This species is most closely related to *Sphyræna commersonii* Cuvier & Valenciennes,[2] of the eastern part of the Indian Ocean. It differs from *S. commersonii* in being less slender, in having a somewhat longer pectoral fin, and in having the black blotches on the soft dorsal and anal fins.

[1] *Sphyræna idiastes* Snodgrass & Heller, MS., Fishes of Tropical Islands of Eastern Pacific.

[2] *Sphyræna commersonii* Cuv. & Val., His. Nat. Poiss., III, p. 352; Günther, Cat. Fishes Brit. Mus., II, p. 338.

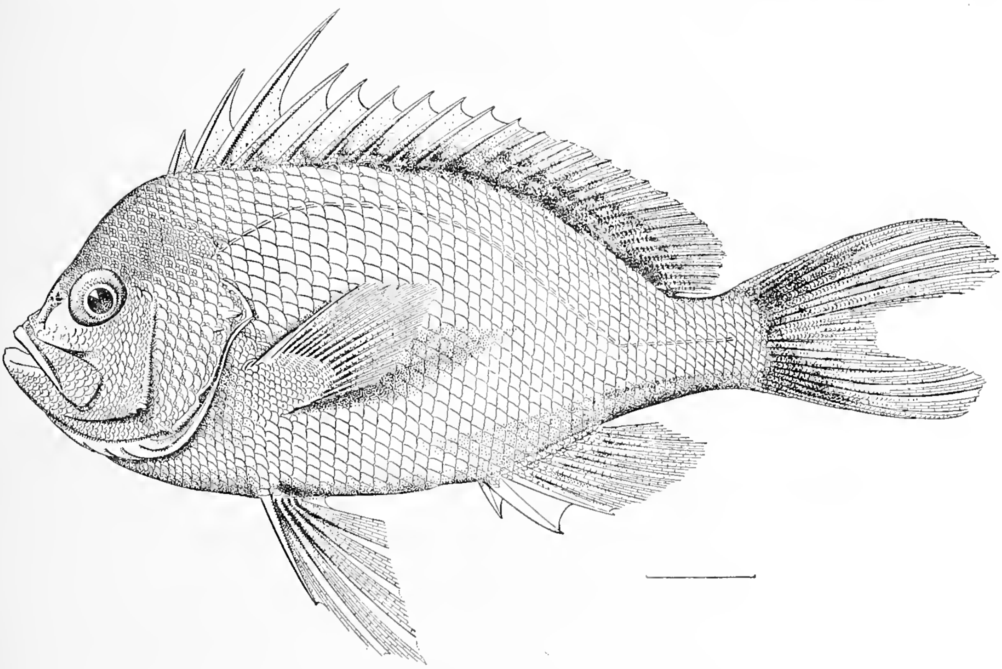
Five specimens taken by me at Honolulu and several secured by Dr. T. D. Wood.

Type No. 49693, U. S. N. M.

This species is named for Mr. R. E. Snodgrass, who has made various contributions to ichthyology.

The following are the measurements and the numbers of fin rays and scales of four specimens:

Sphyræna snodgrassi.	No. 1.	No. 2.	No. 3.	No. 4.	Sphyræna snodgrassi.	No. 1.	No. 2.	No. 3.	No. 4.
Length in millimeters	257	225	222	207	Interorbital	.05	.05	.05	.05
Depth	.15	.14	.16	.15	Space between dorsal fins	.20	.16	.19	.19
Head	.31	.31	.30	.33	First dorsal spines	V	VI	V	V
Pectoral	.12	.11	.12	.12	Second dorsal rays	10	10	10	10
Ventral	.11	.10	.10	.11	Anal rays	9	9	9	9
Eye	.065	.06	.06	.065	Scales (longitudinal)	80	82	82	80
Snout	.14	.15	.15	.15	Scales (transverse)	9–10	9–10	9–10	9–10



3. *Anthias fuscipinnis* Jenkins, new species. Type.

Family SERRANIDÆ.

Anthias fuscipinnis Jenkins, new species. Fig. 3.

Depth of body 2.5 in length; head 2.8 in length. D. x, 17; A. III, 7. Pectoral 1.31 in head. Ventral about equal to head. Eye 4 in head. Interorbital slightly wider than eye. Maxillary reaching to below middle of eye. Narrowest part of preorbital a little less than 2 in eye. Branchiostegals, 7; gillrakers on lower arm of first branchial arch, 34. Mouth very oblique. Lower jaw somewhat projecting, just entering profile. Upper profile of head reëntrant before the nostrils; from here to nape steep and almost straight, in one specimen rather prominently convex before the eyes; strongly bulging at nape in front of dorsal spines. Profile of back straight from front of first dorsal to anterior rays of soft dorsal; from here descending to caudal peduncle, the upper edge of which is on a level with the tip of the snout. Ventral profile less convex and less angular than the upper. Opercle with two flat spines, the upper the larger; lower part of edge of opercle serrated. Angle of preopercle with one or two small spines; both vertical and horizontal margins of preopercle serrated. Preorbital entire, edge of suborbital hidden by scales. Teeth in sides of jaw minute, in villiform bands; two small canines in front of upper jaw, two to six in front of lower jaw.

First dorsal spine short, less than eye; second more than twice as long as the first; third nearly twice the second, prominently longer than the succeeding spines; fourth spine 1.66 in the third; spines from fourth to tenth decrease regularly in length, tenth 1.25 in fourth. Soft dorsal somewhat rounded, longest rays equal to fifth spine. First anal spine a little shorter than the first dorsal; third anal spine equal to second dorsal, slender and a little longer than the second anal spine. Soft anal short, median rays longest, a little longer than longest rays of soft dorsal. Caudal rather large, deeply forked, longest rays equal to length of head, longer than longest dorsal spine; lower lobe a little smaller than upper. Ventrals longer than pectorals, about equal to head, acute, second ray longest. Pectorals pointed, median rays longest. All parts of the head and body except the preorbital and jaws scaled. Scales ctenoid and ciliated. Lateral line strongly arched anteriorly, beginning above upper end of gill cleft on eighth scale below the dorsal spines; at the highest part it is on the fourth row from the back and on the twentieth from the ventral median line.

Color in alcohol: Plain pale reddish-yellow (probably red in life), dusky on scaly part of base of soft dorsal and of posterior part of spinous dorsal and about base of caudal.

This fish is related to *Anthias margaritaceus* Hilgendorf of Japan, differing from descriptions of that species in having a greater number of scales in a vertical row on the body and a greater number of gillrakers on the lower arm of the first branchial arch, in having the ventral fins longer than the pectorals, in having no filamentous prolongations on any of the dorsal or caudal rays, and in being of a uniform coloration on the head and body, *A. margaritaceus* being spotted with large white blotches. The alcoholic specimens may not, however, be reliable on this last point.

(*Fuscus*, dusky; *pinnis*, fin.)

Three adult specimens obtained by Dr. Wood at Honolulu. Type No. 49695, U. S. N. M.

The following are measurements of the three specimens and numbers of fin rays and scales:

Anthias fuscipinnis.	No. 1.	No. 2.	No. 3.	Anthias fuscipinnis.	No. 1.	No. 2.	No. 3.
Length in millimeters	179	157	146	Third dorsal spine	.26	.21	.23
Depth	.41	.41	.42	First dorsal	X	X	X
Head	.32	.36	.38	Second dorsal	17	17	17
Pectoral	.25	.24	.26	Second anal	7	7	7
Ventral	.30	.32	.32	Scales in lateral line	44	47	50
Eye	.08	.08	.09				

Family LUTIANIDÆ

Aphareus flavivultus Jenkins, new species. Fig. 4.

Head equal to depth of body; depth of body 3 in length. D. x, 11; A. iii, 8. Scales 10–73–18. Pectoral 1.33 in head; ventral 1.66 in head. Eye a little shorter than the snout, equal to width of interorbital. Maxillary reaching the posterior margin of pupil. Preorbital and opercles entire, no spine on opercle. Preorbital transversely fluted. Nostrils very small, the posterior circular, exposed; anterior a vertical slit with a dermal flap attached to its posterior edge covering it. Teeth all minute, villiform, in bands in the jaws, in the upper jaw an outer row of very slightly enlarged teeth. Head naked except cheeks, opercle, subopercle, and sides of top of head. Profile of head and body almost regularly fusiform. Caudal fin large, deeply forked, lobes equal, longest rays a little shorter than head. Dorsal fin rather low, third spine longest; first short, 2.5 in eye; second a little shorter than third, which is 2.5 in head, following spines successively shorter, tenth 1.33 in third spine. Anterior soft rays of dorsal same length as last spine, the posterior rays slightly decreasing in length, but the last ray elongated, about 2 in head and three times the length of the penultimate ray. Anal spines weak, the third longest, equaling the sixth dorsal spine. Soft anal similar to soft dorsal but shorter, last ray prolonged, as is last dorsal. Pectorals and ventrals pointed, upper rays of pectorals and outer rays of ventrals longest. Pectoral a little lunate at base, the lower rays very slightly produced. (Not correctly shown in the figure, as the tips were broken in the specimens drawn.) Pectoral 1.5 in head; ventral a little shorter than head. Scales rather large, cycloid. Lateral line almost imperceptibly convex dorsally, anteriorly; straight posteriorly.

Color in alcohol: Dusky-silvery, vertical fins brownish, bare parts of head brown. In life a broad brilliant yellow area on face, or little narrower than interorbital, reaching from occiput to tip of snout.

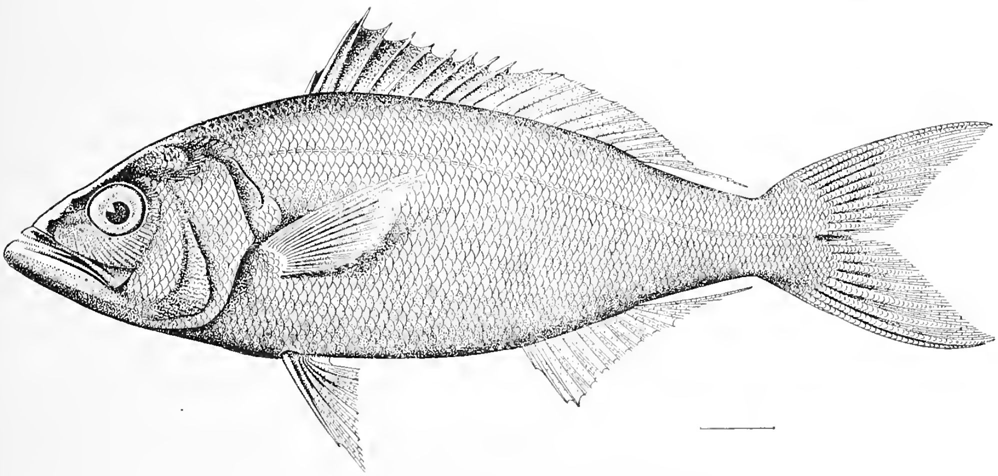
This species is closely allied to *Aphareus furcatus* (Lacépède),[1] of the Red Sea and westward to Japan, differing from descriptions and figures of the latter species in the presence of the bright yellow facial area.

(*Flavus*, yellow; *vultus*, face.)

One adult specimen collected by me at the Hawaiian Islands and two young ones secured by Dr. Wood at Honolulu. Type No. 49691, U. S. N. M.

The following are the comparative measurements and the numbers of fin rays and scales:

Aphareus flavivultus.	No. 1.	No. 2.	No. 3.	Aphareus flavivultus.	No. 1.	No. 2.	No. 3.
Length in millimeters..	110	113	310	Interorbital............	.09	.10	.08
Head.....................	.30	.31	.30	Dorsal spines............	X	X	X
Depth....................	.33	.33	.31	Second dorsal rays......	11	11	11
Pectoral.................	.24	.24	.23	Second anal rays........	8	8	8
Ventral..................	.22	.22	.18	Scales on lateral line....	75	71	73
Eye......................	.10	.10	.08				



4. *Aphareus flavivultus* Jenkins, new species. Type.

Family POMACENTRIDÆ.

Eupomacentrus marginatus Jenkins, new species. Fig. 5.

Head 2.66 in length of body; depth 2. D. XIII, 16; A. II, 12. Scales 3–29–11. Tubes on lateral line 20. Eye 3.5 in head. Interorbital about equal to snout, 3 in head. Profile of head evenly and gently rounded from tip of snout to front of dorsal, profile from snout to base of ventrals less convex than that to the dorsal; from front of dorsal fin to middle of second dorsal gently convex, abruptly descending from here to caudal peduncle; ventral outline from base of ventrals to caudal peduncle evenly convex. Caudal peduncle short, 3 in head. Preorbital narrow, width below front of eye about equal to eye. A few small serrations on suborbital beneath posterior half of eye. Posterior limb of preopercle serrated, inclined somewhat back of perpendicular. First three dorsal spines a little shorter than the others, which are of about equal length and 2 in head. Median soft rays longest, 1.5 in head, posterior rays two-thirds of anterior. First anal spine short, second about equal to dorsal spines. Soft anal similar in shape to soft dorsal, median rays equal to median soft dorsal rays. Lobes of caudal rounded, the upper the larger. Scales 3–29–11, those on anterior part of body larger than those on posterior part. Lateral line on first 20 transverse rows of scales on body follows fourth longitudinal row, but on account of the difference in size of the scales it is much nearer the back posteriorly and

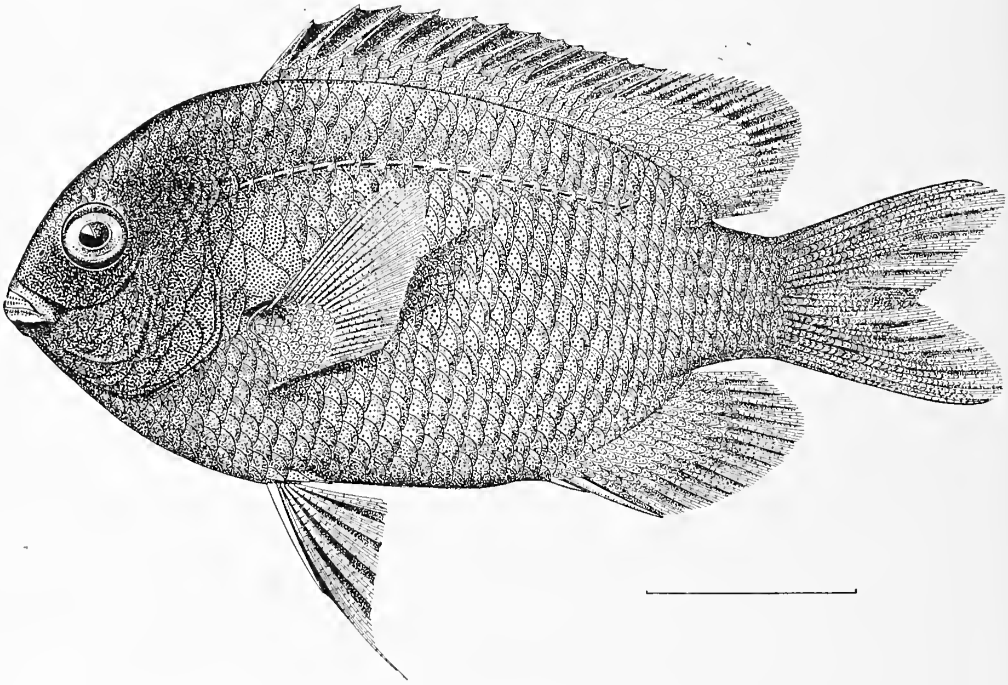
[1] *Labrus furcatus* Lacépède, Hist. Nat. Poiss., III, pp. 424, 477, pl. 21, fig. 1.

Aphareus furcatus Cuvier & Valenciennes, Hist. Nat. Poiss., VI, p. 487, pl. 167 *b;* Günther, Cat. Fishes Brit. Mus., I, p. 386; Fische der Südsee, p. 17; Bleeker, Atlas Ichthy., VIII, p. 80, pl. 299, fig. 2.

anteriorly. Pectoral fin equal to head, upper rays longest. Ventral fin equal to pectoral, outer rays somewhat prolonged into tapering filament. Teeth one-rowed, truncate at top.

Color in life: Ground-color dark-drab; central portion of scales olivaceous, each one with black on lower part of posterior edge forming vertical bands on body; axil black; outer border of dorsal fin above scaled part black; pectoral dusky olivaceous, black at base; ventral and anal black; caudal dusky with posterior border lighter; iris bright yellow.

It is probable that the specimens here described belong to the species called *Pomacentrus nigricans*[1] by Quoy & Gaimard, from the Hawaiian Islands. They differ from Quoy & Gaimard's description, however, in having the dorsal fin edged with black, and in being of a general slate color with indistinct dusky vertical bands as described above and not "uniform brownish black." The numerous specimens examined by me all show these mentioned color characteristics. The original *nigricans* of Lacépède, with the eyes blue instead of bright yellow, is from an unknown locality and can not be the same.



5. *Eupomacentrus marginatus* Jenkins, new species. Type.

(*Marginatus*, in reference to black margin of dorsal fin.)

Numerous specimens taken by me at Honolulu and others by Dr. Wood and by Dr. Jordan. Type No. 49700, U. S. N. M.

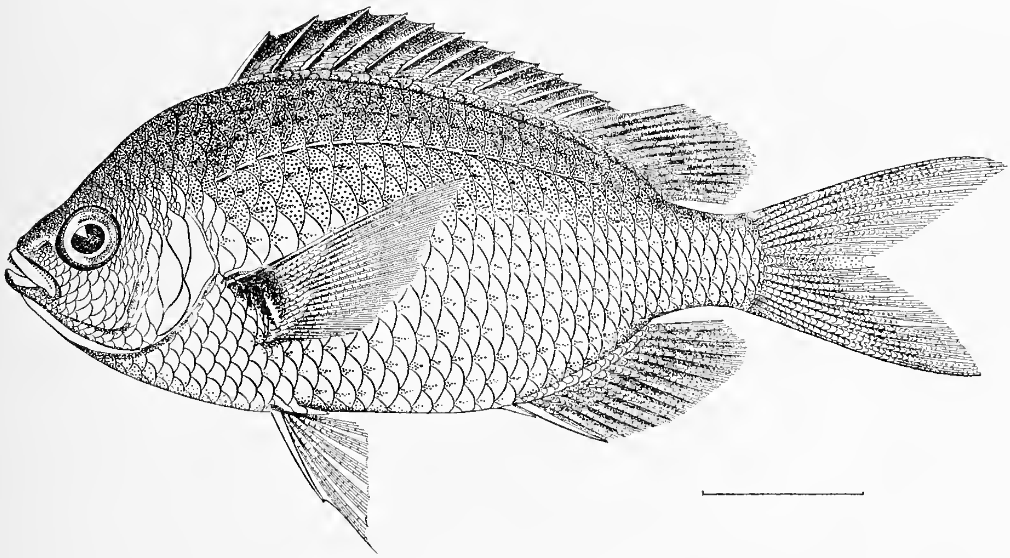
The following are the measurements and numbers of fin rays and scales of four specimens:

Eupomacentrus marginatus.	No. 1.	No. 2.	No. 3.	No. 4.	Eupomacentrus marginatus.	No. 1.	No. 2.	No. 3.	No. 4.
Length in millimeters	96	92	80	73	Snout	.10	.10	.09	.09
Head	.30	.29	.29	....	Dorsal spines	XIII	XIII	XIII	XIII
Depth	.47	.52	.50	.49	Second dorsal rays	16	16	16	16
Pectoral	.28	.30	.30	.31	Second anal rays	12	12	12	12
Ventral	.27	.30	.30	.31	Scales (longitudinal)	29	29	29	27
Eye	.08	.08	.09	.10	Scales (transverse)	3–10	3–11	3–11	3–11
Interorbital	.09	.10	.10	.10	Tubes on lateral line	20	20	20	20

[1] *Pomacentrus nigricans* Quoy & Gaimard, Voyage Uranus, Zoölogie, p. 399, Sandwich Islands; Cuvier & Valenciennes, Hist. Nat. Pois., V, p. 425, 1830; Günther, Cat. Fishes Brit. Mus., IV, p. 34, 1862, not *Holocentrus nigricans* Lacépède, Hist. Nat. Poiss., IV, pp. 332, 367, 1803; locality unknown; collected by Commerson.

Chromis velox Jenkins, new species. Fig. 6.

Head 3.5 in length of body; depth 2.33 in length. D. XIV, 11; A. II, 11 or 12. Profile of head and body regularly and symmetrically rounded above and below, except the head before eyes where it is slightly concave; in some the nape appears somewhat bulging, due to the depression below. Length of caudal peduncle a little less than 2 in head, depth at middle equal to its length. Eye elliptical, 3 in head, equal to interorbital space. Interorbital convex. Snout 4 in head. Preorbital at narrowest part 3 in eye, its edge entire. Edge of suborbital concealed by scales. Preopercle entire, its angle rounded. Opercular margin entire, without spines. Teeth conical, in a single series in each jaw. First dorsal ray equal to eye, two-thirds of third; third and fourth longest, 2 in head; following spines successively shorter, last slightly shorter than second. Soft dorsal rounded; first rays abruptly longer than last spine, equal to third and fourth spines, last ray equal to fourth spine. First anal ray very short, the second equal to tenth spine. Soft anal longer than soft dorsal, rounded, median rays equal soft dorsal rays. Caudal deeply forked, upper lobe the longer, longest rays 3 in length of body. Pectoral large, pointed, upper rays longest, 3 in length of body. Ventrals a little shorter than head, slightly greater than 4 in length of body. All parts of head and body, except lips and a minute ridge from nostril to eye, scaled, and scales on opercle enlarged. Scales on body 4–29–9. Lateral line arched, beginning above upper end of gill cleft, extending over first 20 rows of scales.



6. *Chromis velox* Jenkins, new species. Type.

Color in alcohol: Brownish or dusky olive above, below silvery yellowish; base of pectoral black, color not extending to axil on body; about eight indistinct longitudinal dusky streaks along sides of body, below dorsal dark region, following rows of scales; membrane of spinous dorsal black; soft anal and dorsal dusky; caudal dusky brown.

(*Velox*, swift.)

Three specimens taken by me at Honolulu, two secured by Dr. Wood. Type No. 49698, U. S. N. M.

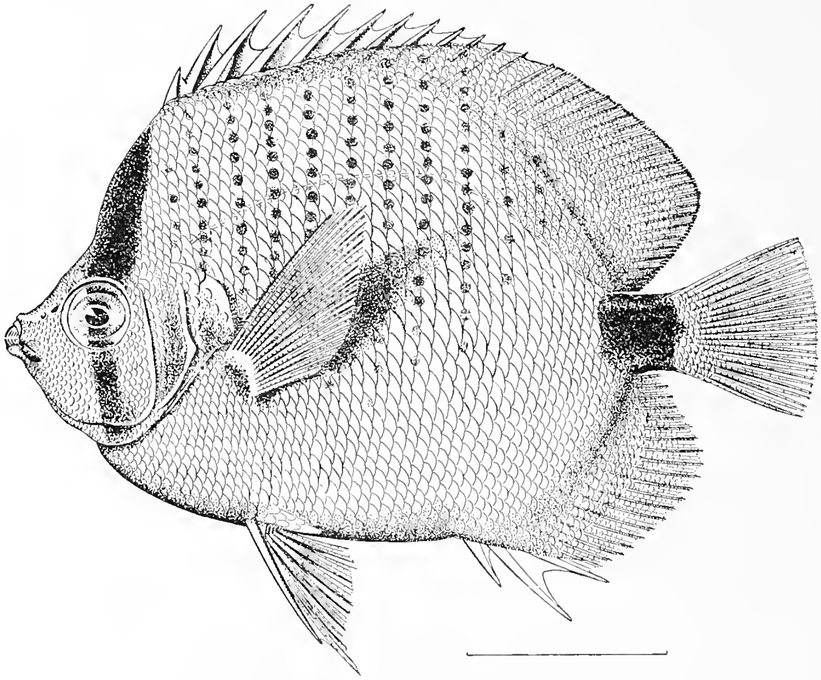
The following are the measurements and numbers of fin rays and scales of four specimens:

Chromis velox.	No. 1.	No. 2.	No. 3.	No. 4.	Chromis velox.	No. 1.	No. 2.	No. 3.	No. 4.
Length in millimeters	118	123	119	115	Snout	.08	.07	.07	.07
Head	.27	.28	.28	.28	Dorsal spines	XIV	XIV	XIV	XIV
Depth	.43	.43	.44	.44	Second dorsal rays	11	11	11	11
Pectoral	.33	.35	.35	.34	Second anal rays	11	12	11	12
Ventral	.24	.23	.24	.22	Scales (longitudinal)	28	28	28	28
Eye	.09	.08	.09	.09	Scales (transverse)	4–9	4–9	4–9	4–9
Interorbital	.10	.09	.10	.09	Tubes on lateral line	20	19	19	20

Family CHÆTODONTIDÆ.

Chætodon mantelliger Jenkins, new species. Fig. 7.

Head 3.5 in length of body; depth 1.5 in length. D. XII, 22; A. III, 19. Body ovate, greatest depth through middle of pectoral fin; anterior upper profile of head concave. Snout prominently projecting, a little less than eye, 3.75 in head. Eye circular, 3 in head. Lower margin of suborbital not visible. Margin of preopercle entire, angle rounded, posterior limb vertical, lower horizontal. Interorbital slightly less than eye. First dorsal spine 2 in second, second three-fourths of third, following spines about same length, last slightly shorter than others. Soft dorsal rounded, median rays longest, a little longer than longest spine, first same length as last spine, last equal to first spine. First anal spine about two-fifths of second; second and third about equal, 1.5 in head. Soft anal a little shorter than soft dorsal, otherwise similar to it, median rays equal to median dorsal rays. Pectorals and ventrals about equal, a little shorter than head. Caudal peduncle short, length equal to interorbital, about three-fourths of its depth. Edge of caudal fin straight, oblique, upper rays longest, 1.33 in head. Scales, 9–57–22. Scales on anterior part of body, except those of nape and on the ventral region between the head, pectorals, and ventrals, much larger than those of posterior part of body. Lateral line strongly arched, beginning above upper end of gill cleft and ending just below fifth ray from end of soft dorsal.



7. *Chætodon mantelliger* Jenkins, new species. Type.

Color in life: General color light yellow; chin and front part of snout red; ocular band only a little narrower than eye above orbit, a little wider than pupil below, inclined somewhat obliquely backward from eye above and below; interorbital yellow; a yellow stripe on level of pupil running across the snout from one eye to the other; about eight vertical rows of black spots, each smaller than pupil, on sides of body, extending from front of dorsal fin to middle of body and reaching from back to level of pectoral, occurring on every third vertical row of scales; caudal peduncle black, the black extending in small amount for a short distance along bases of dorsal and anal fins; caudal fin bright yellow, the general yellow color of body becoming a bright sulphur yellow on posterior parts of dorsal and anal fins; extreme margin of soft dorsal and anal fins, especially posteriorly, black; ventrals yellow; iris nearly white with upper and lower parts dark where ocular band passes through eye.

This species is closely related to *Chætodon miliaris* Quoy & Gaimard,[1] of the East Indies, differing from it in having the spots in rows on every third vertical series of scales instead of on each scale.

(*Mantellum*, mantle, in reference to arrangement of spots on the body.)

Numerous specimens collected by me at Honolulu, two secured by Dr. Wood. Type No. 49699, U. S. N. M.

The following are the comparative measurements and the numbers of the fin rays and scales of three specimens:

Chætodon mantelliger.	No. 1.	No. 2.	No. 3.	Chætodon mantelliger.	No. 1.	No. 2.	No. 3.
Length in millimeters..	82	80	65	Snout....................	.08	.10	.10
Head....................	.30	.30	.30	Dorsal spines............	XIII	XIII	XIII
Depth...................	.65	.60	.72	Second dorsal rays......	22	22	22
Pectoral................	.26	.27	.27	Second anal rays........	19	18	20
Ventral.................	.24	.27	.25	Scales (longitudinal)...	57	53	51
Eye.....................	.10	.10	.10	Scales (transverse)......	9–22	8–18	9–24
Interorbital............	.09	.09	.09	Tubes on lateral line....	36	42	38

Chætodon sphenospilus Jenkins, new species. Fig. 8.

Head 3.33 in length; depth 1.33 in length. D. XIII, 23; A. III, 19. Profile of head from snout to first dorsal very steep, first dorsal spine being situated over posterior edge of opercle. Snout very slightly obtuse. Profile of head slightly reëntrant before eye. Profile of body from the nape almost regularly ovate to caudal peduncle. Eye elliptical, longer diameter longitudinal, 3 in head. Interorbital very slightly wider than length of eye, equal to snout. Preorbital four-fifths of vertical diameter of eye. Posterior edge of preopercle vertical, angle regularly rounded and minutely serrated. Posterior border of opercle slightly notched, without spines. Deep pit below lower end of premaxilla and another just back of lower end of maxilla. Dorsal spines back of second of approximately uniform length, third 1.5 in head, second a little shorter than third, first less than half of second; posterior spines successively slenderer. First soft rays equal to last spine, median rays longest, last very short, about one-third of median rays, so that border of fin is rounded and posterior margin receding. Soft anal of same size and shape as soft dorsal. Second and third anal spines of equal length, equal to third dorsal spine; first one-half of second. Posterior edge of caudal fin about straight, a little oblique, upper rays being longest. Pectoral equal to head, upper rays longest. Ventral equal to pectoral, outer rays longest. All parts of head and body scaled except maxillaries and symphysis of lower jaw. Scales on head and fins very small, those on body mostly larger, those of anterior half of body back of bases of pectorals and ventrals much larger. Scales on body 7–56–21. Lateral line not concurrent with dorsal profile, begins back of upper part of eye, curves upward to black spot on upper part of side of body, then downward to base of last dorsal ray, where it terminates.

Color in life: Fins and upper part of body yellow, especially bright on ventral and anal fins; ocular band black, passing vertically through eye, width on side of head equal to eye, on top of head covers space from above front of eye to first dorsal spine; face in front of ocular band white; tip of snout dusky; lower part of body, below end of pectoral fin, white; large black spot on upper part of side of body below the eighth to the tenth spines, extending vertically from the third scale below the dorsal fin to about the tenth scale from the anal spines; upper part of spot forming large round black blotch, lower part, below eleventh scale from dorsal, abruptly tapering and much paler than the upper part, so as to form a long slender downward wedge-shaped prolongation, comparatively faintly colored from an upper very black round spot; in front of lower part of lateral spot, above pectoral fin, seven light-yellow oblique bands (inclined from below upward and backward); a black band around middle of caudal peduncle bordered before and behind by a white band; soft dorsal and anal fins with a submarginal black band, widest posteriorly on horizontal rays of each, tapering to a narrow line on median and anterior rays, within this a white band, and beyond it a very narrow marginal line of white.

This species is very closely related to *Chætodon unimaculatus* Bloch,[2] differing from it mainly in the

[1] *Chætodon miliaris* Quoy & Gaimard, Zoölogie du Voyage de Freycinet, p. 380, pl. 62, fig. 5; Cuvier & Valenciennes, Hist. Nat. Poiss., VII, p. 26; Günther, Cat. Fishes Brit. Mus., II, p. 31; Günther, Fische der Südsee, p. 46, pl. 35, fig. A.

[2] *Chætodon unimaculatus* Bloch, pl. 201, fig. 1; Bloch & Schneider, p. 221; Cuvier & Valenciennes, Hist. Nat. Poiss., VII, p. 72; Günther, Cat. Fishes Brit. Mus., II, p. 11.

Tetragonopterus unimaculatus Bleeker, Atlas Ichthy., IX, p. 45, pl. 375 (Chæt., pl. 13), fig. 5.

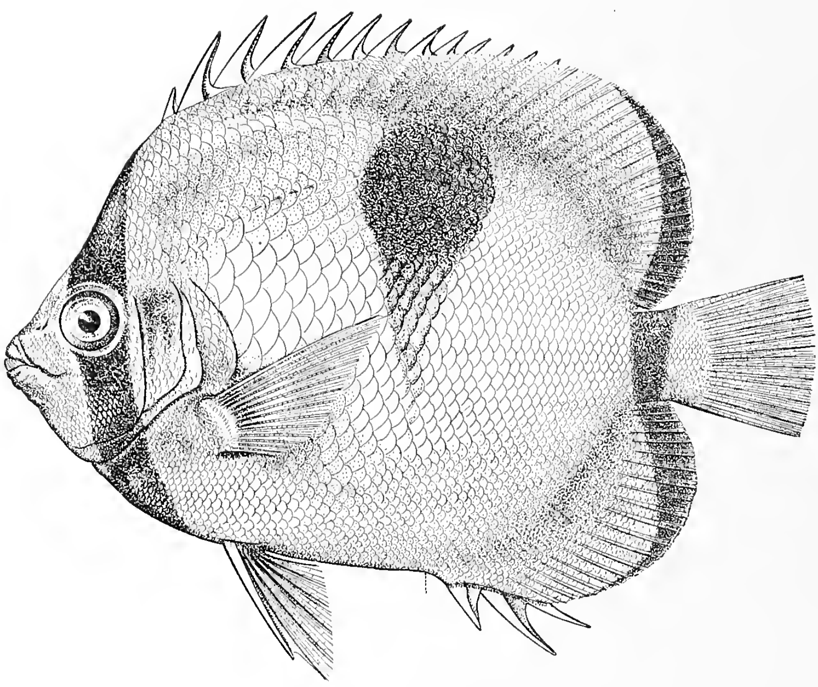
shape of the black spot on the upper part of the side of the body. In all descriptions and figures of *C. unimaculatus* this mark is represented as an ocellated spot having a definite circular outline without any ventral tapering prolongation. On all of the Hawaiian specimens (preserved in formalin and alcohol) examined by me the ventral prolongation of the spot is distinctly marked and could not possibly be overlooked.

(Σφήν, a wedge; σπίλος, spot.)

Numerous specimens secured by me at Honolulu. Type No. 49705, U. S. N. M.

The following are the measurements and the numbers of fin rays and scales of four specimens:

Chætodon sphenospilus.	No. 1.	No. 2.	No. 3.	No. 4.	Chætodon sphenospilus.	No. 1.	No. 2.	No. 3.	No. 4.
Length in millimeters	96	92	86	77	Dorsal spines	XIII	XIII	XIII	XIII
Head	.28	.29	.32	.30	Second dorsal rays	22	23	23	23
Depth	.62	.71	.70	.73	Second anal rays	19	19	19	19
Eye	.09	.09	.10	.11	Scales (longitudinal)	54	56	58	50
Interorbital	.11	.10	.11	.11	Scales (transverse)	7–23	7–21	7–21	7–20
Snout	.10	.10	.12	.11					



8. *Chætodon sphenospilus* Jenkins, new species. Type.

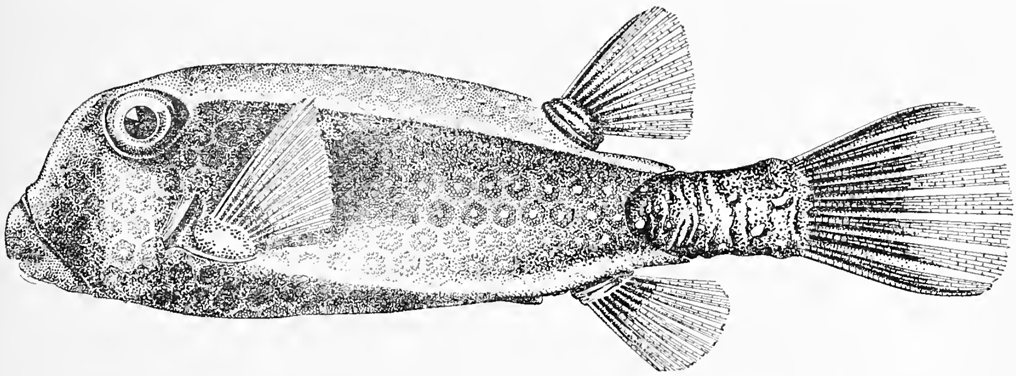
Family OSTRACIIDÆ.

Ostracion camurum Jenkins, new species. Fig. 9.

Body four-sided, back rounded, interorbital flat, profile before eye prominently convex. Head 3.75 in length of body; depth 3 in length. Interorbital space at front of eyes equal to head, wider posteriorly. Eye 2.66 in middle of interorbital, 2 in snout. Dorsal profile of snout very steep; forming a reentrant angle just above tip of snout (this angle not very conspicuous in the smaller specimens). Sides of body concave. Greatest dorsal width 3 in length, equal to depth; greatest ventral width 2.6 in length. Carapace forming wide bridge back of dorsal fin; length of part back of dorsal fin 2 in

snout. Posterior lateral edges of carapace deeply reentrant. Caudal peduncle, measured on side, equal to snout. Pectoral 5.5 in length. Longest dorsal rays 1.66 in head. Longest anal rays a little shorter than head. Caudal rounded, median rays equal to length of head. Carapace formed of hexagonal plates; plates varying a little in size, the larger ones about 3.5 in width of front part of interorbital, 13 plates in longitudinal series from interorbital band to front of dorsal, 10 on side of body from above posterior edge of pectoral to end of carapace, 13 along median ventral line from chin to anus. Plates above pectoral not distinctly defined. Surface of carapace covered with small, even-sized tubercles evenly distributed or somewhat grouped at the center of the plates. Five specimens in the collection present but little structural variation. The hump on the forehead below the level of the upper rim of the eye is very conspicuous on all.

Color in life: General color dark, nearly black, lighter patch below each eye, belly dark blue; irregular golden band between eyes on top of head; back covered with many small white dots; sides with golden dots; caudal peduncle black with row of golden spots on side, white dots on dorsal surface; axil blue; fins dusky, posterior half of caudal lighter; iris white with orange spots. The color of different specimens varies considerably. The spots on the back do not correspond with the plates of the carapace and are more numerous than the plates. Two specimens apparently had the sides blue



9. *Ostracion camurum* Jenkins, new species. Type.

in life, one with dark centers to the plates, the other with a dark spot in the center of the upper plates of the side, and a white spot surrounded by a black ring on each of the lower lateral plates. In alcohol all the specimens have a brownish color, dusky in places; a yellowish interorbital stripe and a large area below the eye of the same color; the basal half of the caudal fin dark brown, contrasting conspicuously with the colorless distal half, the two regions being separated by a crescentic line, concave posteriorly.

Four specimens obtained by me at Honolulu and two by Dr. Wood are identical structurally with one in the Stanford University collection taken by Messrs. Snodgrass and Heller, at Clipperton Island, off Mexico. The latter, however, has black spots on the back instead of white spots, and a row of white spots just below the upper lateral edge of the carapace.

Type No. 49697, U. S. N. M.

The following are the measurements and the numbers of fin rays of five Hawaiian specimens:

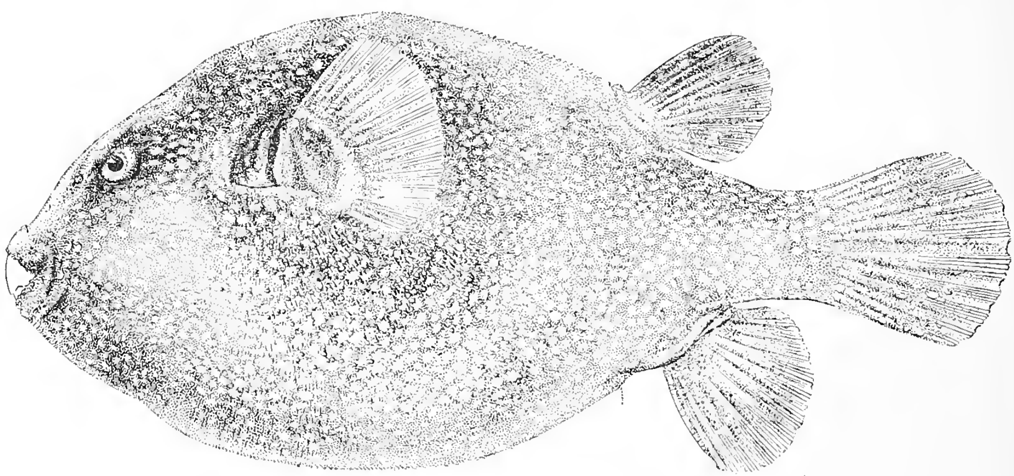
Ostracion camurum.	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	Ostracion camurum.	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
Length in millimeters	104	102	94	88	86	Eye	.10	.11	.11	.12	.12
Depth	.34	.34	.34	.34	.34	Interorbital	.23	.24	.23	.22	.24
Width of body (dorsal)	.34	.35	.32	.35	.35	Snout	.20	.20	.22	.23	.23
Width of body (ventral)	.38	.37	.39	.40	.40	Caudal peduncle (dorsal edge)	.13	.13	.15	.13	.13
Pectoral	.18	.21	.20	.20	.20	Dorsal rays	9	9	9	9	9
Longest dorsal ray	.16	.15	.17	.17	.16	Anal rays	9	9	9	9	9
Longest anal ray	.13	.14	.15	.15	.14	Pectoral rays	10	10	10	10	10
Longest caudal ray	.27	.28	.26	.25	.27						

Family TETRAODONTIDÆ.

Ovoides latifrons Jenkins, new species. Fig. 10.

Length of head 2.7 in length of body, width of head 3.7. Snout (to tip of dental plates) 2 in head. Interorbital space flat, wide, 6.25 in length of body, equal to snout from nostril. Eye 4.33 in head. Nostrils a simple, bifid, nonperforate tentacle on each side. Dorsal profile evenly rounded, belly distensible. D. 10; A. 12; P. 19. Dorsal rays 2 in head; anal rays a little shorter than dorsal. Pectoral 1.33 in snout. Caudal fin rounded, equal to distance from tip of dental plates to center of pupil. All parts of body and posterior parts of head covered with small, simple, setæ-like spines, mostly embedded in the skin, having only the tips projecting, most of them inclined backward. None on the caudal peduncle. (The specimen described has the base of the dorsal fin covered by a fold of the integument from the right side. This, however, occurs as a "freak" in *Ovoides setosus.*)

Color in life: Light brown, covered with rather closely set white spots. Spots distributed over entire surface of head and body, those on the chin smaller than the others, a few on dorsal, anal, and caudal fins; pectorals spotted at base; nasal tentacles black; iris yellow.



10. *Ovoides latifrons* Jenkins, new species. Type.

This species is very similar to *Ovoides setosus*[1] of the west coast of tropical America, differing from it in the greater width of the interorbital space, the interorbital being 8.33 in the length of the body in *O. setosus* and 6.25 in *O. latifrons.*

One specimen, 188 mm. long, collected by me at Honolulu. Type No. 49696, U. S. N. M.

The following table gives comparative measurements and numbers of fin rays of the one specimen of *Ovoides latifrons* and of three specimens of *O. setosus* in the Stanford University collection from the Revillagigedo, Cocos, and Galapagos Islands:

Measurements.	Ovoides latifrons.	Ovoides setosus.			Measurements.	Ovoides latifrons.	Ovoides setosus.		
	No. 1.	No. 1.	No. 2.	No. 3.		No. 1.	No. 1.	No. 2.	No. 3.
Length in millimeters	188	205	142	141	Longest anal ray	.16	.14	.18	.19
Length of head	.37	.33	.31	.32	Longest pectoral ray	.14	.15	.15	.17
Width of head	.27	.28	.31	.32	Longest caudal ray	.25	.22	.21	.27
Snout	.20	.17	.17	.19	Dorsal rays	10	....	11	10
Eye	.095	.10	.10	.10	Anal rays	12	12	12	11
Interorbital width	.16	.12	.13	.12	Pectoral rays	19	18	17	17
Longest dorsal ray	.18	....	.17	.19					

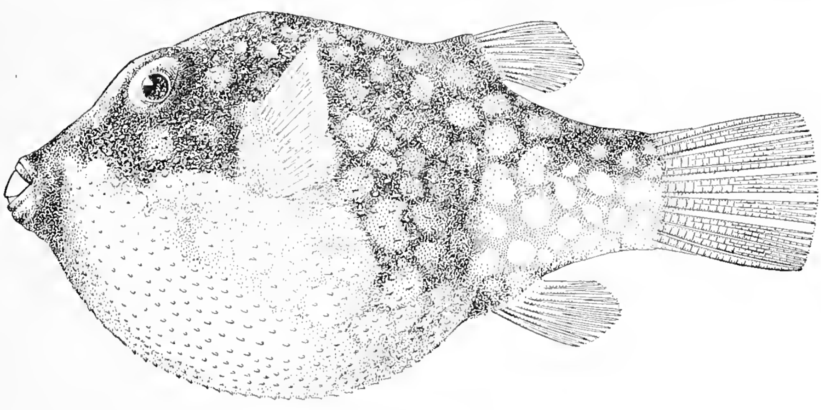
[1] *Tetraodon setosus* Rosa Smith, Bull. Cal. Acad. Sci., II, p. 6, 1886 (Mexico).

Family TROPIDICHTHYIDÆ.

Tropidichthys jactator Jenkins, new species. Fig. 11.

Head 2.66 in length of body; depth of body from back to lower edge of base of pectoral 3.33 in length. Eye equal to interorbital space, 2 in snout. D. 9; A. 10; P. 16; C. 7. Profile rising from tip of snout to middle of back where the median dorsal crest forms a prominent point. Dorsal profile of head concave from tip of snout to eyes, straight from eyes to dorsal prominence. Interorbital space very slightly concave. Profile descending to a straight line from apex of back to dorsal fin, from dorsal fin to caudal fin descending with gentle concavity. Caudal peduncle deep anteriorly, depth just back of dorsal and anal fins equal to snout; much less deep posteriorly, depth just before bases of caudal rays 2.33 in head. Ventral parts of body much dilated, depth below pectoral 1.25 in depth above pectoral. Dorsal and anal fins very short, dorsal above anal; rays equal, about 3 in head. Caudal slightly rounded, median rays equal to snout. Pectoral wide, distal edge slightly concave; upper rays longest, 2.66 in head. Body and head everywhere except on caudal peduncle covered with small asperities consisting of small, erectile, two-rooted spines directed backward; spines largest on belly.

Color in alcohol: Dark brown above and on sides, belly pale yellowish; dark parts with numerous, regularly distributed, pale (apparently bluish in life), round or polygonal spots; spots largest on sides where the brown ground-color appears as a network between them, obsolete on fore part of head in one specimen, extending distinct to tip of snout in a smaller one, none smaller than pupil, those on sides three-fourths of eye in diameter; dusky ring about eye, most conspicuous above; fins colorless.



11. *Tropidichthys jactator* Jenkins, new species. Type.

Very similar to *Tropidichthys punctatissimus* (Günther)[1] of the west coast of tropical America, but differs from this species in the much greater size of the spots (none of them in *C. punctatissimus* being greater than the pupil) and in having the belly much more distended.

(*Jactator*, boaster.)

Two small specimens, 30 and 42 mm. in length, taken by me at Honolulu. I have compared these with 7 specimens, 35 to 60 mm. in length, of *C. punctatissimus* in the Stanford University collection, taken at Panama by Dr. C. H. Gilbert. Type No. 49703, U. S. N. M.

Genus EUMYCTERIAS Jenkins, new genus.

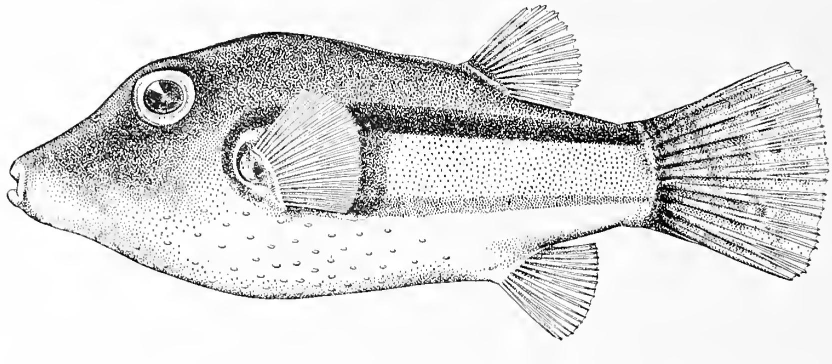
General characters of *Tropidichthys* Bleeker (=*Canthigaster* Swainson, diagnosis only; no type), the back being compressed and produced into a blunt prominence midway between the eyes and the dorsal fin. The nostrils, however, consist of a single simple opening on each side. In *Tropidichthys* the nostrils are obsolete.

(*Εὖ*, true; *μυκτήρ*, nostril.)

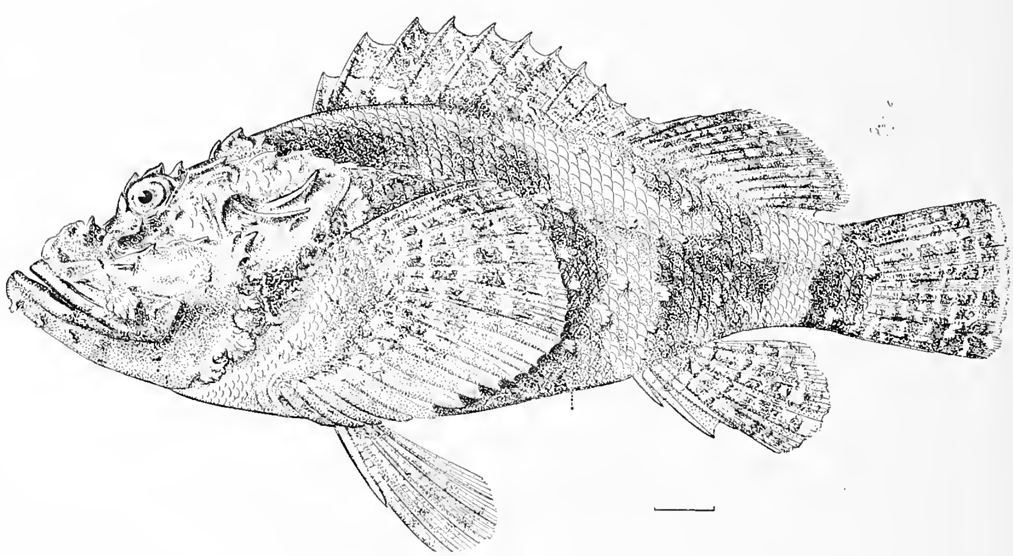
[1] *Tetrodon punctatissimus* Günther, Cat. Fishes Brit. Mus., VIII, p. 302, 1870 (Panama).
Tetrodon oxyrhynchus Lockington, Proc. Acad Nat. Sci. Phila. 1881, p. 116 (Gulf of California).

Eumycterias bitæniatus Jenkins, new species. Fig. 12.

Head 2.66 in length of body; depth a little greater than head. Back compressed, culminating in a very obtuse point above middle of pectoral fin. Profile from tip of snout to before eyes somewhat concave; straight from interorbital to top of dorsal prominence, descending in a straight line from here to base of caudal fin, being interrupted, however, at middle by elevation bearing dorsal fin. Ventral outline evenly curved, no more convex than the dorsal. Eye 3.33 in head. Snout 1.75 in head. Interorbital concave, slightly greater than eye, 3 in head. One nostril in each side, each a simple opening with slightly raised margin, but scarcely tubular. Distance from eye to nostril 2 in



12. *Eumycterias bitæniatus*, nov. gen. et sp. Type.



13. *Scorpænopsis cacopsis* Jenkins, new species. Type.

distance from nostril to tip of snout. Front of dorsal fin midway between dorsal prominence and base of caudal fin, outline rounded; rays 10, longest 1.5 in snout. Caudal slightly rounded, median rays equal distance from tip of snout to center of pupil. Anal similar to dorsal, front of its base below posterior end of base of dorsal. Pectoral broad (in specimen median and lower rays on both sides broken), upper rays 2.5 in head. A few minute spines on lower surface of body; surface otherwise smooth.

Color in alcohol: General color brown or dusky above, paler brownish below; a wide dusky band from base of upper rays of the caudal running forward along side of body, above base of pectoral, to upper end of gill slit, here becomes narrow and curves downward around anterior edge of gill slit and

then goes backward again below it as a narrow band below base of pectoral and along side of body, parallel with the upper band, to a little below middle of caudal fin; a black spot on outer side of base of pectoral; bases of upper and lower caudal rays black.

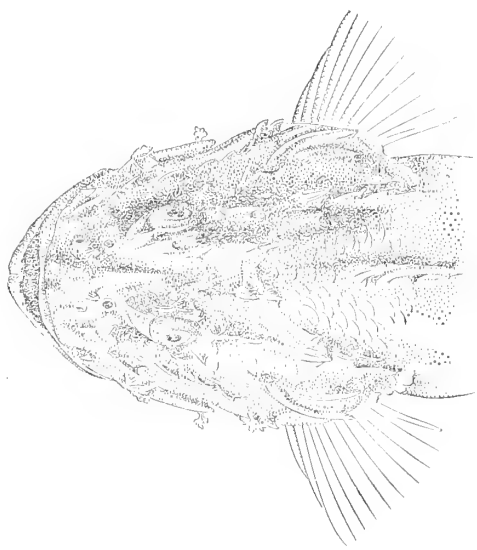
One specimen, 52 mm. long, secured by Dr. Wood at Honolulu. Type No. 49702, U. S. N. M.

Family SCORPÆNIDÆ.

Scorpænopsis cacopsis Jenkins, new species. Figs. 13 and 14.

Head 2.6 in length of body. Depth 3 in length. D. XII, 10; A. III, 5; P. 18. Scales in 50 transverse series. Specimen described, large and robust, 347 mm. in length. Greatest depth at front of dorsal fin; depth here equal to distance from tip of upper jaw to vertical through base of first dorsal spine, so that upper profile of head is inclined at angle of about 45°. Lower outline of head descending at lesser angle from tip of lower jaw to below pectorals. Mouth on level with median pectoral rays; lower jaw projecting beyond upper a distance equal to one-half diameter of eye, most of the teeth in front of lower jaw being exposed. Dorsal and ventral outlines of body back of front of dorsal and base of pectorals symmetrically converging to base of caudal peduncle, where depth is 3.5 in head. Eye small, 2.5 in snout, on level with middle of caudal peduncle. Snout 2.33 in head, equal to third dorsal spine, its upper profile in front of posterior nostril very convex, forming an abrupt hump. A prominent spine on each side of upper end of this hump between inner rims of nostrils of same side. Interorbital very concave, least width equal to distance from eye to first nostril. Maxilla reaches posterior margin of pupil. Below eye a deep cavity on side of head, deepest anteriorly. A rectangular depressed area on top of head back of eyes. Teeth all villiform, in wide bands in front and on sides of jaws and in a V-shaped patch on vomer.

The spines of the head are distributed as follows: Above, three on upper rim of the orbit, a fourth back of and within the most posterior of these on top of head at anterior angle of the occipital depression, two approximated spines on occiput at posterior angle of occipital depression; laterally, a row of three spines back of eye, the last at posterior end of opercle, one between the second of these and the two occipital spines of same side, a row of about seven spines from side of snout below suborbital cavity to middle of opercle, angle of opercle with two dorsally curved spines, the upper the larger. Numerous dermal flaps are distributed over the head in the following manner: One on posterior margin of posterior nostril, folding over nostril like a lid, a large one attached to suborbital and overlapping maxilla, several small ones on posterior end of maxilla, three large ones along lower limb of preopercular margin, one on each side of preopercle below lower row of spines on side of head; on lower jaw two flaps just back of symphysis, three on each side back of these just within ramus of jaw. Third dorsal spine longest, about 3 in head; the following three of about same length as third; seventh to eleventh gradually shorter; twelfth about one-third longer than the eleventh. Anterior soft rays a little longer than the posterior soft rays, equal to fourth spine. Anal short, two-thirds of length of soft dorsal; first spine two-thirds of second; second and third spines equal to the fourth dorsal spine. Pectoral very large, upper and median rays longest and of equal length, about 2 in head, lower rays successively shorter; the lower ten much thickened, angulated near bases, especially the short lowermost ones, so as to be bent somewhat inward. Ventrals narrow, 1.66 in head.


14. *Scorpænopsis cacopsis*, dorsal view of head.

Scales in 50 transverse series, each row almost vertical below the lateral line, oblique above. Lateral line straight, extending from above gill cleft to middle of base of caudal fin. Ten scales in oblique series from first dorsal spine to lateral line, twenty from lateral line to anus. A few dermal flaps irregularly distributed over sides of body, about twelve along lateral line on each side.

Color in alcohol: Dusky-brown and gray, everywhere mottled, except on ventral surface, which is uniformly pale; colors rather clouded on sides of body, each covering a large but indistinctly defined area, finely mottled on head and bases of pectorals; dusky-brown and gray forming irregular cross-bands on all the fins except spinous dorsal, which is mottled.

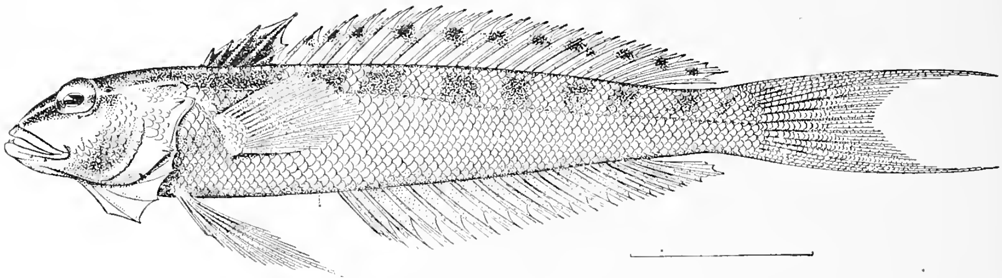
This species is probably allied to *Scorpænopsis gibbosa* Bloch & Schneider,[1] of the Red Sea, Indian Ocean, and Society and Samoan islands. It agrees with *S. gibbosa* in lacking palatine teeth, in having the strongly convex hump on the snout, and in having the lower pectoral rays thickened and bent inward, but differs in having a wider interorbital and in not having the dorsal spines shortened, the longest, the third, being in *S. gibbosa* 4 in head, and in *S. cacopsis* 3 in head.

(*Κάκος*, ugly; *ὄψις*, the face.)

One large specimen taken by me at Honolulu. Type No. 49690, U. S. N. M.

The following gives the comparative measurements and the numbers of fin rays and scales:

Scorpænopsis cacopsis.	No. 1.	Scorpænopsis cacopsis.	No. 1.
Length in millimeters	347	Third dorsal spine	.14
Head	.40	Dorsal spines	XII
Depth	.35	Second dorsal rays	10
Pectoral	.21	Second anal rays	5
Ventral	.24	Pectoral rays	18
Eye	.06	Scale rows	50
Interorbital	.07	Tubes on lateral line	25
Snout	.15		



15. *Parapercis pterostigma* Jenkins, new species. Type.

Family PERCOPHIDÆ.

Parapercis pterostigma Jenkins, new species. Fig. 15.

Parapercis Bleeker=*Percis*, Bloch & Schneider, Syst. Ichthy., p. 179, 1807; Cuvier & Valenciennes, III, p. 259; Günther, Cat. Fishes Brit. Mus., II, p. 237; not of Scopoli.

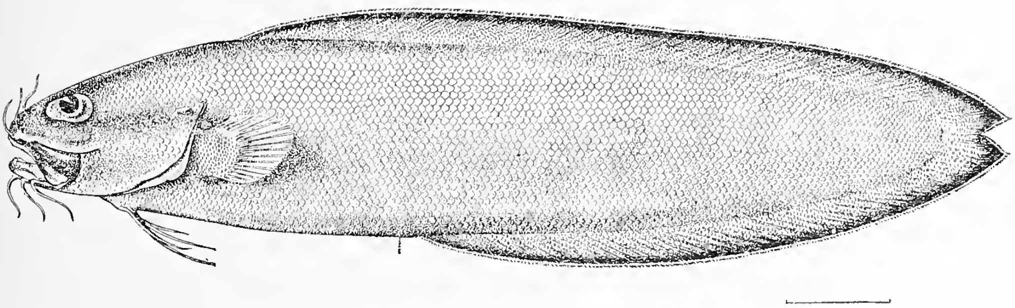
Head about 4 in length of body; depth 6 in length. D. v, 21; A. 17. Body elongate; dorsal profile of head convex, gently rising from snout to nape, ventral profile of head symmetrical with dorsal. Eye 1.25 in snout. Interorbital about flat or almost imperceptibly concave, 1.5 in eye. Suborbital equal to interorbital. Opercular margin above with two small spines, below with minute serrations. Branchiostegals 6. Gillrakers very short, 10 on lower arm of arch. Fourth dorsal spine longest, equal to snout; first two spines very short, third but little shorter than fourth, fifth about equal to third. Soft rays of dorsal of uniform length, 2.5 in head, except first, which is shorter, and last, which is longer than the others. Anal similar to but shorter than soft dorsal, begins beneath fourth soft ray of dorsal. Caudal rather slender, deeply forked, lobes equal (rays in specimen examined broken, but longest probably equal to head.) Pectoral pointed, lower rays longest, 1.5 in head Ventrals elongate, tapering, inner rays longest, equal to head; tips reach fourth anal ray. Teeth villiform, in bands in each jaw and in a crescentic patch on vomer; four canines in front of each jaw, those of lower jaw considerably smaller than those of upper; an outer series of slightly enlarged teeth in each jaw. Top of head, cheeks, sides of snout, jaws and fins naked, other parts scaled. Scales 7–61–15.

[1] *Scorpæna gibbosa* Bloch & Schneider, p. 192, pl. 44; Günther, Cat. Fishes Brit. Mus., II, p. 119, 1860; Fische der Südsee, p. 79, pl. 53, 1873.

Color in alcohol: Ground-color pale-brownish, a series of 9 quadrate dark blotches across back, separated by interspaces shorter than their own lengths, the first interspace just before front of first dorsal spine; apparently a yellow stripe from tip of snout through anterior nostril to middle of front of eye; a series of 13 black spots along the soft dorsal fin nearer the outer margin than base of the fin; other fins plain.

Two specimens secured by Dr. Wood at Honolulu. Type No. 49701, U. S. N. M. The following are their comparative measurements and the numbers of fin rays and scales:

Parapercis pterostigma.	No. 1.	No. 2.	Parapercis pterostigma.	No. 1.	No. 2.
Length in millimeters	100	89	Interorbital	.05	.05
Head	.27	.26	Snout	.09	.09
Depth	.17	.17	Dorsal spines	V	V
Pectoral	.18	.19	Second dorsal rays	21	20
Ventral	.26	.20	Anal rays	17	17
Eye	.07	.07	Scales on lateral line	61	57



16. *Brotula marginalis* Jenkins, new species. Type.

Family BROTULIDÆ.

Brotula marginalis Jenkins, new species. Fig. 16.

Body not much elongate, depth 5 in length. Head equal to depth. Caudal region rounded, not tapering to a point. Profile of head ascending in a straight line from tip of snout to front of dorsal. Greatest width of body near anterior end, about 1.5 in head; caudal region much compressed. Distance from tip of snout to anus 2.33 in length. Dorsal rays 96; fin beginning a little back of base of pectoral, of about uniform height throughout. Anal with 70 rays, beginning just back of anus, of same height as dorsal and continuous with it around caudal end of body. (In this example, which doubtless is abnormal in this particular, the caudal part of the fin is conspicuously notched on axis of body.) Vertical height of dorsal and of anal a little less than eye, 4.75 in head. Snout from all aspects bluntly rounded, equal to horizontal diameter of eye. Eye on right side of specimen ovate, larger end posterior, longitudinal diameter 4 in head; eye on left side elongate ovate, constricted at middle. Maxillary reaching to below posterior margin of eye. Preorbital 2 in longitudinal diameter of eye. Mouth oblique. Teeth minute, villiform, in bands in each jaw and on palatines, in a V-shaped patch on vomer. Snout above with six tentacles, longest about equal to eye in length, two at lower end of each nasal bone, one on posterior rim of each anterior nostril. Lower jaw also with six tentacles, each longer than eye, three on each side, just back of symphysis. Anterior nostril with a very short tube, larger than the posterior, situated somewhat nearer eye than tip of snout. Posterior nostril almost sessile, having only very slightly raised rim. Movable spine on side of head arising from upper anterior angle of opercle. Gillrakers 3 on upper end of lower arm of arch. Branchiostegals 8. Pectoral rounded, longest rays 2 in head. Ventrals at symphysis of humeral arch, the two arising close together, each filamentous, 1.66 in head, bifid near middle, outer part the shorter, about half the length of inner from bifurcation. All parts of head and body scaled; scales elongate ovate, ctenoid, in 165 transverse series, 44 in transverse row at middle of body.

Color in alcohol: Body and head dark brown, paler below, jaws dusky; dorsal and anal fins brown with narrow white marginal band and black submarginal band, the black widest on the posterior divergent tips of the caudal ends of the two fins.

This species is similar to *Brotula multibarbata*[1] of Japan, differing from it in having the ventrals distinctly bifid, in having the front of the dorsal fin back of the bases of the pectorals, and in having the very distinctly outlined submarginal black band on the dorsal and anal fins instead of simply a diffusion of black along the same areas.

One specimen, 220 mm. long, collected by Dr. Wood at Honolulu. Type No. 49694, U. S. N. M.

(*Marginalis*, in reference to the black border of the dorsal and anal fins.)

The following are measurements and numbers of fin rays and scales of the specimen:

Brotula marginalis.	No. 1.	Brotula marginalis.	No. 1.
Length in millimeters	220	Interorbital	.03
Head	.20	Snout	.05
Depth	.20	Dorsal rays	96
Pectoral	.10	Anal rays	70
Ventral	.12	Scales (longitudinal)	165
Eye (longitudinal)	.05	Scales (transverse)	44

LELAND STANFORD JR. UNIVERSITY, *October 1, 1900.*

[1] *Brotula multibarbata* Schlegel, Fauna Japonica, Poiss., p. 251, pl. III, fig. 2, 1847; Güenther, Cat. Fishes Brit. Mus., IV, p. 371, 1862.

PARASITES OF FISHES OF THE WOODS HOLE REGION.

BY

EDWIN LINTON, Ph. D.,

Professor of Biology, Washington and Jefferson College.

CONTENTS.

PARASITES OF FISHES OF THE WOODS HOLE REGION.

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INTRODUCTION.

It is a matter of much importance that our knowledge of parasites which infest fishes be greatly extended, and it is of almost equal importance that the parasites of invertebrates be studied, since many, if not most, of the parasites of fishes pass a portion of their lives in invertebrate hosts which serve as food for fishes. It is thus evident that the parasites of invertebrates, the food of fishes, and the parasites of fishes are quite closely interrelated subjects.

The more our knowledge of the life-histories of fish parasites is increased the speedier will be the diagnoses and the more effective will be the remedies which may be made and applied in all cases of epidemic diseases among fishes which are due to parasites. Naturally such cases can be handled best in ponds and lakes and the smaller streams. But with a thorough knowledge of the interrelations of marine life, it is not unreasonable to think that even in the sea something may be done to turn the scale in favor of those fishes which are useful as food.

Certain economical questions relating to parasitism have been discussed by the author in an article in the Fish Commission Bulletin for 1893 entitled "Some observations concerning fish parasites," and in the Fish Commission Bulletin for 1897 in an article entitled "An economical consideration of fish parasites."

This paper contains: (1) An annotated list of the parasites of Woods Hole fishes which have been described by the author in various papers published in the Reports and Bulletins of the United States Fish Commission and the Proceedings of the United States National Museum.

(2) A preliminary notice of collections made in the summers of 1899 and 1900 at Woods Hole, Massachusetts.

(3) Notes on Nematodes which have been collected in successive years, for the most part in the waters of southern New England.

(4) Notes on the food of the fishes which were examined for entozoa.

The authority for the names of fishes is Jordan & Evermann's Fishes of North and Middle America (Bulletin 47, U. S. National Museum).

The author's papers are referred to by number. See page 424 for the list and numbers.

Notes on the food of the fishes which have been examined have been introduced with greater fullness than has been done in previous papers. The arrangement of

the subject-matter under the several hosts has greatly facilitated this plan. In all cases, where not explicitly stated to be otherwise, the food notes state the food as it was actually found in the Woods Hole fishes.

Analytical keys for the determination of genera of cestodes and species of distomes mentioned in this paper have been introduced. For the determination of monogenetic trematodes recourse may be had to Pratt's Synopsis of the Heterocotylea (American Naturalist, vol. XXXIV, pp. 645–662).

But few changes have been made in the nomenclature adopted in former papers, although this is not because the author is entirely satisfied with the old. The cestode originally called *Orygmatobothrium angustum* has been referred in this paper to the genus *Crossobothrium*. Following the nomenclature of Pratt's excellent synopsis, *Octobothrium denticulatum* becomes *Dactylocotyle denticulatum*, *Octoplectanum affine* becomes *Diclidophora affinis*, *Nitzschia elegans* becomes *N. elongata*, and *Tristomum rudolphianum* becomes *T. molæ*.

The generic name *Distomum* is retained, as it is sufficiently definite for the purposes of this paper. During the past summer the author has been much impressed by the variety of shapes which the same species of distome may assume, even when it is under the same conditions. When variations in conditions are made, as, for example, when some are placed in fresh water, others in sea water, others in normal salt solution, or when they are killed under pressure with application of heat, or when different killing fluids are used; further, when differences in age of specimens are considered, as affecting the occurrence of spines on the body or around the mouth, or the relative proportions and even disposition of the reproductive organs, the variety of forms to be found in the same species is very great. The variation in proportions of the muscular suckers, even, is often considerable among the individuals of the same species, and the ova, while furnishing a valuable criterion of species, frequently vary in the same species and even in the same individual.

The explanation of the wide distribution of such a form as the species identified as *Distomum appendiculatum* is doubtless to be found in the nature of the intermediate host or hosts. Pratt[1] describes an immature appendiculate distome which he finds in copepods, which, without much doubt, is the young of this species. Since copepods furnish the principal food of the majority of the young of the food-fishes, it is easy to understand how the latter became infected. It is to be noted further that most of the fish in which this distome was found were young.

While this report concerns itself principally with helminth entozoa, a few ectoparasites, both helminths and copepods, and a few sporozoa are noted. Some deep-water fishes are included which do not belong to the Woods Hole fauna.

Notes on the nematodes, which have been collected by or for the author at Woods Hole, are given, together with notes on nematodes which were found in a collection of entozoa belonging to the United States National Museum, the cestodes and trematodes of which were reported on in vols. XIX and XX of the Proceedings of the National Museum (Nos. 4, 5, and 6, p. 424). The great majority of these nematodes are immature and no attempt has been made to give them specific names. A few adult forms, with sufficiently conspicuous characteristics, have been described as new species. These will be found in the alphabetic list of nematodes (p. 410–411).

[1] A Contribution to the Life-history and Anatomy of the Appendiculate Distomes, Zoolog. Jahrb. XI, 1898.

Alphabetical lists have been prepared, both of the parasites which have been found and the fishes which have been examined; in the former the name of the host is also given. By means of these lists and the numerous cross references, which will be found in the text, the arrangement of the material under the hosts should not be inconvenient to the zoologist; while the collection of the several species which have been found under each host, together with such food notes as have been made, will be a beginning of the practical economic study of parasitism in the food-fishes. It is very desirable that a summary of the invertebrate intermediate hosts of fish parasites be made, but thus far very little work has been done on the parasites of invertebrates.

Efficient assistance in the collection of material was rendered in the summer of 1899 by Messrs. J. A. Stewartson and W. W. Francis, and in 1900 by Mr. C. W. Stone. Grateful mention is also made of Mr. Vinal N. Edwards, whose amazing energy, vast knowledge of local conditions, and unfailing accuracy have been of invaluable service.

List of parasites of Woods Hole fishes.

ACANTHOCEPHALA.

Parasite.	Host.	Page.
Echinorhynchus acus Rudolphi	Carcharias littoralis	428
	Enchelyopus cimbrius	478
	Gadus callarias	475
	Leptocephalus conger	436
	Limanda ferruginea	484
	Lophius piscatorius	487
	Macrourus bairdii	480
	Melanogrammus æglefinus	476
	Merluccius bilinearis	473
	Mola mola	465
	Myxocephalus æneus	466
	Opsanus tau	468
	Paralichthys dentatus	481
	Paralichthys oblongus	483
	Pseudopleuronectes americanus	485
	Roccus lineatus	455
	Spheroides maculatus	464
	Stenotomus chrysops	457
	Urophycis chuss	478
Echinorhynchus agilis Rudolphi	Anguilla chrysypa	435
	Carcharinus obscurus	427
	Morone americana	456
	Opsanus tau	468
	Tylosurus marinus	442
Echinorhynchus attenuatus Linton	Acipenser brevirostris	435
Echinorhynchus carchariæ Linton	Carcharias littoralis	428
Echinorhynchus fusiformis Zeder	Opsanus tau	468
Echinorhynchus globulosus Rudolphi	Acipenser rubicundus	435
	Anguilla chrysypa	435
Echinorhynchus incrassatus Molin	Lophius piscatorius	487
	Paralichthys dentatus	481
	Pomatomus saltatrix	450
Echinorhynchus pristis Rudolphi	Cynoscion regalis	459
	Lobotes surinamensis	457
	Palinurichthys perciformis	453
	Tylosurus acus	443
Echinorhynchus proteus Westrumb	Archosargus probatocephalus	459
	Centropristes striatus	456
	Cynoscion regalis	459
	Roccus lineatus	455
	Paralichthys dentatus	481
	Pomatomus saltatrix	450
Echinorhynchus sagittifer Linton	Centropristes striatus	456
	Cynoscion regalis	459
	Paralichthys dentatus	481
	Pomatomus saltatrix	450
	Rhombus triacanthus	453
	Stenotomus chrysops	457
Echinorhynchus serrani Linton	Centropristes striatus	456
Echinorhynchus thecatus Linton	Morone americana	456
Echinorhynchus sp. *a* and *b*	Lopholatilus chamæleonticeps	471

List of parasites of Woods Hole fishes—Continued.

NEMATODA.

Parasite.	Host.	Page.
Acanthocheilus nidifex Linton	Galeocerdo tigrinus	426
Acanthocheilus sp	Carcharias littoralis	428
Agamonema capsularia Diesing, referred to under.	Anguilla chrysypa	435
	Clupea harengus	437
	Scomber scombrus	444
Agamonema papilligerus	See under Scomber scombrus	444
Ascaris acanthocaudata Cobbold	See under Melanogrammus æglefinus	476
Ascaris capsularia Rudolphi. See under.	Gadus callarias	476
	Scomber scombrus	444
Ascaris brevicapitata sp. nov	Galeocerdo tigrinus	425
Ascaris clavata Rudolphi	Gadus callarias	475
	Pollachius virens	474
	Scomberomorus maculatus	446
	See also under Pomolobus mediocris	438
	and Scomber scombrus	444
Ascaris habena Linton	Opsanus tau	468
Ascaris increscens Molin	Coryphæna hippurus	452
	Lophius piscatorius	487
Ascaris incurva Rudolphi	Hippoglossus platessoides	481
	Seriola zonata	448
	Scomberomorus maculatus	446
	Tetrapterus imperator	447
	Xiphias gladius	448
Ascaris inquies sp. nov	Rachycentron canadum	452
Ascaris linstowi sp. nov	Nematonurus goodei	479
Ascaris macruri Linstow and Ascaris macruroidei Linstow.	See under Nematonurus goodei	479
Ascaris neglecta Leidy	Chilomycterus schœpfi	465
Ascaris rigida Rudolphi	See under Lophius piscatorius	488
Ascaris rotundata Rudolphi	Chimæra affinis	434
	Raja eglanteria	431
	Raja erinacea	430
	Raja ocellata	431
Ascaris sp	Cottunculus thomsonii	467
	Hemitripterus americanus	467
	Mustelus canis	425
	Myxocephalus æneus	467
	Paralichthys dentatus	481
	Phycis tenuis	477
	Pomolobus mediocris	438
	Pseudopleuronectes americanus	485
	Sarda sarda	445
	Sciænops ocellatus	461
	Stenotomus chrysops	458
Ascaris sp., immature; see also Nematodes, immature.	Alosa sapidissima	440
	Brosmius brosme	479
	Carcharias littoralis	429
	Clupea harengus	437
	Dasyatis centrura	432
	Glyptocephalus cynoglossus	487
	Lagocephalus lævigatus	464
	Macrourus bairdii	480
	Menticirrus saxatilis	461
	Microgadus tomcod	475
	Osmerus mordax	441
	Roccus lineatus	455
	Sciænops ocellatus	461
	Scomber scombrus	444
	Tylosurus acus	443
Cucullanus elegans Zeder	Salvelinus fontinalis	441
Cucullanus globosus Zeder	Gadus callarias	476
	Lophius piscatorius	488
Cucullanus sp	Fundulus heteroclitus	441
Cucullanus sp	Rhombus triacanthus	453
Dacnitis hians Dujardin	Leptocephalus conger	436
Dacnitis sphærocephala Dujardin	Acipenser sturio	435
Filaria rubra Leidy	Centropristes striatus	456
	Roccus lineatus	455
Filaria serrata sp. nov	Phycis tenuis	477
Ichthyonema globiceps Rudolphi	Lobotes surinamensis	457
	Pomatomus saltatrix	450
	Scomberomorus maculatus	446
	Tarpon atlanticus	437
Ichthyonema sanguineum Rudolphi	Paralichthys dentatus	482
Ichthyonema sp	Chætodipterus faber	463
Ichthyonema sp	Hippoglossus platessoides	481
Ichthyonema sp	Sarda sarda	446
Ichthyonema sp	Sphyrna zygæna	428
Lecanocephalus annulatus Molin	Roccus lineatus	455
Nematodes, immature, many evidently belonging to the genus Ascaris; usually encapsuled on the viscera.	Anguilla chrysypa	435
	Antimora viola	477
	Bothus maculatus	484
	Carcharinus milberti	426

List of parasites of Woods Hole fishes—Continued.

NEMATODA—Continued.

Parasite.	Host.	Page.
Nematodes, immature, many of them evidently belonging to the genus Ascaris; usually encapsuled on the viscera.	Centropristes striatus	456
	Cynoscion regalis	459
	Enchelyopus cimbrius	479
	Fundulus heteroclitus	441
	Gadus callarias	476
	Isurus dekayi	429
	Leptocephalus conger	436
	Limanda ferruginea	484
	Lobotes surinamensis	457
	Lophius piscatorius	488
	Lopholatilus chamæleonticeps	472
	Melanogrammus æglefinus	476
	Menidia notata	443
	Merluccius bilinearis	473
	Mola mola	465
	Myxocephalus æneus	467
	Paralichthys dentatus	481
	Paralichthys oblongus	484
	Phycis tenuis	477
	Pollachius virens	474
	Pomatomus saltatrix	450
	Pomolobus pseudoharengus	438
	Prionotus carolinus	470
	Pseudopleuronectes americanus	485
	Raja erinacea	431
	Raja ocellata	431
	Rhombus triacanthus	453
	Salmo salar	441
	Sarda sarda	446
	Scomberomorus maculatus	446
	Sphyrna zygæna	428
	Stenotomus chrysops	458
	Stolephorus brownii	440
	Tautogolabrus adspersus	462
	Trachurops crumenophthalmus	449
	Urophycis chuss	478
Nematode, undetermined	Macrourus bairdii	480
Spiroptera pectinifer sp. nov	Sphyrna zygæna	427

CESTODA.

Parasite.	Host.	Page.
Acanthobothrium coronatum Rudolphi	Raja lævis	431
Acanthobothrium paulum Linton	Dasyatis centrura	433
	Myliobatis freminvillei	434
Anthobothrium laciniatum Linton	Carcharinus milberti	426
	Carcharinus obscurus	427
	Isurus dekayi	429
	Sphyrna zygæna	428
Anthobothrium pulvinatum Linton	Dasyatis centrura	432
Anthocephalum gracile Linton	Dasyatis centrura	433
Calliobothrium eschrichtii Beneden	Mustelus canis	425
Calliobothrium verticillatum Rudolphi	Mustelus canis	425
Calyptrobothrium occidentale Linton	Tetronarce occidentalis	432
Cestode larva	Decapterus macarellus	449
Cestode larva from squid	See under Cynoscion regalis	460
Cestode larva	Sarda sarda	446
Cestode, genus inquirenda	Lopholatilus chamæleonticeps	472
Crossobothrium angustum Linton	Carcharinus milberti	426
	Carcharinus obscurus	427
Crossobothrium laciniatum Linton	Carcharias littoralis	429
Cysts, degenerate	Carcharinus obscurus	427
Cyst	Raja ocellata	431
Cysts in liver	Roccus lineatus	456
Cysts in kidney	Stenotomus chrysops	459
Dibothrium aluteræ Linton	Alutera schœpfii	464
Dibothrium angustatum Rudolphi	Merluccius bilinearis	474
	Rhombus triacanthus	454
Dibothrium crassiceps Rudolphi	Merluccius bilinearis	473
	Pomatomus saltatrix	451
Dibothrium laciniatum Linton	Tarpon atlanticus	437
Dibothrium ligula Donnadieu	Osmerus mordax	441
Dibothrium manubriforme Linton	Istiophorus nigricans	448
	Tetrapterus imperator	447
Dibothrium microcephalum Rudolphi	Mola mola	465
Dibothrium punctatum Rudolphi	Bothus maculatus	484
	Limanda ferruginea	485
	Paralichthys oblongus	484
	Scomber scombrus	445
Dibothrium restiforme Linton	Tylosurus acus	443

List of parasites of Woods Hole fishes—Continued.

CESTODA—Continued.

Parasite.	Host.	Page.
Dibothrium rugosum Rudolphi	Gadus callarias	476
Dibothrium plicatum Rudolphi	Xiphias gladius	448
Dibothrium sp.	Mustelus canis	425
Dibothrium sp., larva	Myxocephalus æneus	467
Dibothrium sp., young	Scomber scombrus	445
Discocephalum pileatum Linton	Carcharinus obscurus	427
Echeneibothrium affine Olsson	See under Rhinoptera bonasus	434
Echeneibothrium larvæ. See Scolex polymorphus.		
Echeneibothrium variabile Beneden	Raja erinacea	431
Echeneibothrium sp.	Myliobatis freminvillei	434
	Rhinoptera bonasus	434
Lecanicephalum peltatum Linton	Dasyatis centrura	433
Ligula chilomycteri	Chilomycterus schœpfi	465
Monorygma chlamedoselachi Lönnberg	See under Isurus dekayi	430
Monorygma sp	Carcharinus milberti	426
	Galeocerdo tigrinus	426
	Isurus dekayi	429
Onchobothrium uncinatum Diesing	Dasyatis centrura	433
Orygmatobothrium angustum Linton. See Crossobothrium angustum.		
Orygmatobothrium crenulatum Linton.	Dasyatis centrura	433
Orygmatobothrium paulum Linton	Galeocerdo tigrinus	426
Otobothrium crenacolle Linton	Sphyrna zygæna	428
Otobothrium dipsacum Linton	Pomatomus saltatrix	451
Paratænia medusia Linton	Dasyatis centrura	433
Phoreiobothrium lasium Linton	Carcharinus milberti	426
	Carcharinus obscurus	427
	Sphyrna zygæna	428
Phoreiobothrium triloculatum sp. nov.	Carcharinus obscurus	427
Phyllobothrium foliatum Linton	Dasyatis centrura	433
Phyllobothrium thysanocephalum. See Thysanocephalum crispum.		
Phyllobothrium sp., immature	Merluccius bilinearis	474
Platybothrium cervinum Linton	Carcharinus obscurus	427
Platybothrium parvum sp. nov	Carcharinus milberti	426
	Isurus dekayi	430
	Sphyrna zygæna	428
Rhinebothrium cancellatum Linton	Dasyatis centrura	433
	Rhinoptera bonasus	434
Rhinebothrium flexile Linton	Dasyatis centrura	433
Rhinebothrium longicolle Linton	Myliobatis freminvillei	433
Rhinebothrium minimum Beneden	Raja lævis	431
Rhodobothrium pulvinatum. See Anthobothrium pulvinatum.		
Rhynchobothrium agile Linton	Myliobatis freminvillei	434
	Rhinoptera bonasus	434
Rhynchobothrium attenuatum Rudolphi	Xiphias gladius	448
Rhynchobothrium bisulcatum. See Tetrarhynchus bisulcatus.		
Rhynchobothrium brevispine Linton	Rhinoptera bonasus	434
Rhynchobothrium bulbifer Linton	Mustelus canis	425
Rhynchobothrium bulbifer, cysts	Alutera schœpfii	464
	Anguilla chrysypa	436
	Cynoscion regalis	460
	Paralichthys dentatus	482
	Pomatomus saltatrix	451
	Scomber scombrus	445
	Scomberomorus maculatus	447
Rhynchobothrium heterospine Linton	Mustelus canis	425
Rhynchobothrium heterospine, cysts	Anguilla chrysypa	436
	Paralichthys dentatus	482
	Siphostoma fuscum	443
Rhynchobothrium hispidum Linton	Dasyatis centrura	433
Rhynchobothrium imparispine Linton	Myliobatis freminvillei	434
	Raja erinacea	431
	Raja lævis	431
	Raja ocellata	431
	Tetronarce occidentalis	432
Rhynchobothrium imparispine, cysts	Anguilla chrysypa	436
	Bothus maculatus	484
	Centropristes striatus	456
	Clupea harengus	437
	Gadus callarias	476
	Leptocephalus conger	436
	Limanda ferruginea	485
	Lophius piscatorius	488
	Melanogrammus æglefinus	476
	Microgadus tomcod	475
	Paralichthys dentatus	482
	Scomber scombrus	445
	Stenotomus chrysops	458
Rhynchobothrium lomentaceum Diesing	Mustelus canis	425
Rhynchobothrium longicorne Linton	Carcharias littoralis	429

List of parasites of Woods Hole fishes—Continued.

CESTODA—Continued.

Parasite.	Host.	Page.
Rhynchobothrium longispine Linton	Dasyatis centrura	433
Rhynchobothrium speciosum Linton, cysts.	Chætodipterus faber	463
	Cynoscion regalis	460
	Lophius piscatorius	488
	Paralichthys dentatus	482
	Pomatomus saltatrix	451
	Remora remora	473
	Roccus lineatus	455
	Scomber scombrus	445
	Scomberomorus maculatus	447
	Stenotomus chrysops	458
	Tylosurus acus	443
Rhynchobothrium tenuispine Linton	Carcharinus milberti	426
	Dasyatis centrura	433
Rhynchobothrium tumidulum Linton	Mustelus canis	425
	Raja erinacea	431
Rhynchobothrium tumidulum, scolices	Opsanus tau	468
Rhynchobothrium wageneri Linton	Dasyatis centrura	433
Rhynchobothrium cysts—too immature for certain identification, or not yet identified.	Alutera schœpfii	464
	Anguilla chrysypa	436
	Caranx chrysos	450
	Carcharias littoralis	429
	Centropristes striatus	456
	Clupea harengus	437
	Cynoscion regalis	460
	Decapterus macarellus	449
	Macrourus bairdii	480
	Merluccius bilinearis	474
	Menidia notata	443
	Microgadus tomcod	475
	Mola mola	466
	Mustelus canis	425
	Myliobatis freminvillei	434
	Myxocephalus æneus	467
	Paralichthys dentatus	482
	Paralichthys oblongus	484
	Phycis tenuis	477
	Pollachius virens	474
	Prionotus carolinus	471
	Rhombus triacanthus	453
	Sarda sarda	446
	Scomberomorus regalis	447
	Stenotomus chrysops	458
	Stolephorus brownii	440
	Tautogolabrus adspersus	462
	Urophycis chuss	478
Scolex polymorphus Dujardin	Anguilla chrysypa	436
	Brevoortia tyrannus	440
	Centropristes striatus	456
	Clupea harengus	437
	Cynoscion regalis	459
	Decapterus macarellus	449
	Fundulus heteroclitus	442
	Lagocephalus lævigatus	464
	Leptocephalus conger	436
	Limanda ferruginea	485
	Lophius piscatorius	488
	Lopholatilus chamæleonticeps	472
	Menticirrus saxatilis	461
	Merluccius bilinearis	474
	Microgadus tomcod	475
	Palinurichthys perciformis	453
	Paralichthys dentatus	482
	Paralichthys oblongus	484
	Pomatomus saltatrix	451
	Pomolobus mediocris	438
	Pomolobus pseudoharengus	439
	Rhombus triacanthus	454
	Sarda sarda	446
	Scomber scombrus	445
	Spheroides maculatus	447
	Stenotomus chrysops	458
	Stolephorus brownii	440
	Tylosurus marinus	442
Spongiobothrium variabile Linton	Dasyatis centrura	453
Synbothrium filicolle Linton, scolex	Dasyatis centrura	433
Synbothrium filicolle, cysts	Brevoortia tyrannus	440
	Cynoscion regalis	460
	Lobotes surinamensis	457
	Mustelus canis	425
	Paralichthys dentatus	482
	Pomatomus saltatrix	451

List of parasites of Woods Hole fishes—Continued.

CESTODA—Continued.

Parasite.	Host.	Page.
Synbothrium filicolle, cysts	Scomberomorus maculatus	447
	Scomberomorus cavalla	447
	Scomberomorus regalis	447
Syndesmobothrium. See Synbothrium.		
Tænia dilatata Linton	Anguilla chrysypa	435
Tænia gibbosa Leidy	See under Sphyrna zygæna	428
Tænia sp	Anguilla chrysypa	435
Tænia sp	Sphyrna zygæna	428
Tænia?	Lopholatilus chamæleonticeps	472
Tetrabotbrium barbatum Leidy	See under Carcharias littoralis	429
Tetrarhynchus bicolor Bartels, cysts and scolices.	Carcharinus obscurus	427
	Coryphæna hippurus.	452
	Galeocerdo tigrinus	426
	Paralichthys dentatus	482
	Sarda sarda	446
	Xiphias gladius	448
Tetrarhynchus bisulcatus Linton	Carcharinus obscurus	427
Tetrarhynchus bisulcatus, cysts and scolices.	Cynoscion regalis	460
	Decapterus macarellus	449
	Lopholatilus chamæleonticeps	472
	Paralichthys dentatus	482
	Paralichthys oblongus	484
	Pomatomus saltatrix	451
	Prionotus carolinus	471
	Pseudopleuronectes americanus	486
	Seriola zonata	448
	Stenotomus chrysops	458
	Tetronarce occidentalis	432
Tetrarhynchus elongatus Wagener	Mola mola	466
Tetrarhynchus erinaceus Beneden, cysts	Cynoscion regalis	460
	Pomatomus saltatrix	451
	Rhombus triacanthus	454
Tetrarhynchus robustus Linton	Dasyatis centrura	433
	Isurus dekayi	430
	Myliobatis freminvillei	434
	Raja lævis	431
	Rhinoptera bonasus	434
Tetrarhynchus tenuis Linton	Dasyatis centrura	433
Tetrarhynchus cysts, too immature for identification, or not yet identified.	Carcharinus obscurus	427
	Chætodipterus faber	463
	Dasyatis centrura	433
	Lophius piscatorius	488
	Mustelus canis	425
	Pseudopleuronectes americanus	486
	Raja erinacea	431
	Rhombus triacanthus	454
	Sarda sarda	446
	Scomberomorus regalis	447
	Spheroides maculatus	447
	Sphyrna zygæna	428
	Tetrapterus imperator	447
Thysanocephalum crispum Linton	Galeocerdo tigrinus	426
Thysanocephalum ridiculum sp. nov	Isurus dekayi	430
Tylocephalum pingue Linton	Rhinoptera bonasus	434

TREMATODA, ECTOPARASITIC.

Dactylocotyle denticulatum Olsson	Pollachius virens	474
Diclidophora affinis Linton	Paralichthys dentatus	482
Epibdella bumpusii Linton	Dasyatis centrura	433
Hexacotyle thynni De la Roche	Sarda sarda	446
Microcotyle sp	Pomatomus saltatrix	451
Nitzschia elegans Bær. See N. elongata.		
Nitzschia elongata Nitzsch	Acipenser sturio	435
Nitzschia papillosa Linton	Gadus callarias	476
Octobothrium denticulatum Olsson. See Dactylocotyle denticulatum.		
Octoplectanum affine Linton. See Diclidophora affinis.		
Tristomum coccineum Cuvier	Xiphias gladius	448
Tristomum læve Verrill	Gymnosarda pelamys	445
Tristomum molæ Blanchard	Mola mola	466
Tristomum rudolphianum Diesing. See T. molæ.		

List of parasites of Woods Hole fishes—Continued.

TREMATODA, ENDOPARASITIC.

Parasite.	Host.	Page.
Diplostomum sp.	Fundulus heteroclitus	442
Diplostomum sp.	Prionotus carolinus	471
Distomum appendiculatum Rudolphi	Achirus fasciatus	487
	Brevoortia tyrannus	440
	Clupanodon pseudohispanicus	438
	Clupea harengus	437
	Cynoscion regalis	460
	Decapterus macarellus	449
	Microgadus tomcod	475
	Myxocephalus æneus	467
	Paralichthys dentatus	482
	Pomolobus mediocris	438
	Pomolobus pseudoharengus	439
	Prionotus carolinus	471
	Pseudopleuronectes americanus	486
	Scomber scombrus	445
	Stenotomus chrysops	459
	Stolephorus brownii	440
	Trachurops crumenophthalmus	449
	Urophycis chuss	478
Distomum areolatum Rudolphi	Morone americana	456
	Pseudopleuronectes americanus	486
	Tautogolabrus adspersus	462
[1] Distomum auriculatum Wedl (?)	Acipenser rubicundus	435
Distomum bothryophoron Olsson	Clupea harengus	437
	Pomolobus pseudoharengus	439
Distomum cestoides Beneden	See under Raja lævis	432
Distomum clavatum Rudolphi	Thunnus thynnus	445
	Xiphias gladius	448
Distomum commune Olsson	See under Limanda ferruginea	485
	and Pseudopleuronectes americanus	486
Distomum contortum Rudolphi	Mola mola	466
Distomum dentatum Linton	Paralichthys dentatus	483
Distomum fœcundum Linton	Lopholatilus chamæleonticeps	472
	See also under Raja lævis	432
Distomum foliatum Linton	Mola mola	466
Distomum fragile Linton	Mola mola	466
Distomum globiporum Rudolphi	Pseudopleuronectes americanus	486
Distomum grandiporum Rudolphi	Anguilla chrysypa	436
	Pseudopleuronectes americanus	486
Distomum gulosum sp. nov	Rhombus triacanthus	454
Distomum hispidum Abilgaard	Phycis tenuis	478
Distomum increscens Olsson	See under Enchelyopus cimbrius	479
Distomum lageniforme Linton	Remora remora	473
Distomum læve Linton	Macrourus bairdii	481
Distomum macrocotyle Diesing	Mola mola	466
	Myliobatis freminvillei	434
Distomum monticellii Linton	Paralichthys dentatus	482
	Pomatomus saltatrix	451
	Remora remora	473
Distomum nigroflavum Rudolphi	Mola mola	466
Distomum nitens Linton	Tylosurus acus	443
[2] Distomum ocreatum Molin	Lopholatilus chamæleonticeps	472
	Merluccius bilinearis	474
	Pollachius virens	475
	Urophycis chuss	478
Distomum pallens Rudolphi	Alutera schœpfii	464
Distomum polyorchis Stossich	Cynoscion regalis	460
Distomum pudens Linton	Paralichthys dentatus	482
Distomum pyriforme Linton	Cynoscion regalis	460
	Menticirrus saxatilis	462
	Palinurichthys perciformis	453
	See also under Paralichthys dentatus	483
	and Stenotomus chrysops	460
Distomum rachion Cobbold (?)	Gadus callarias	476
Distomum rufoviride Rudolphi	See under Roccus lineatus	455
Distomum simplex Rudolphi	Hemitripterus americanus	468
	Leptocephalus conger	436
	Limanda ferruginea	485
	Microgadus tomcod	475
	See also under Pseudopleuronectes americanus	486
Distomum tenue Linton	Roccus lineatus	455
	Opsanus tau	468
var. tenuissime	Morone americana	456
Distomum tornatum Rudolphi	Coryphæna hippurus	452
	Fundulus heteroclitus	442
	Roccus lineatus	455
	Menidia notata	444

[1] Pratt proposes the name Bunodera lintoni for this species.
[2] The name Hemiurus lintoni is proposed for this species by Pratt.

List of parasites of Woods Hole fishes—Continued.

TREMATODA, ENDOPARASITIC—Continued.

Parasite.	Host.	Page.
Distomum valde-inflatum Stossich	Alutera schœpfii	464
	Menidia notata	444
	Spheroides maculatus	464
Distomum veliporum Creplin	Raja lævis	434
Distomum vibex Linton	Spheroides maculatus	464
Distomum vitellosum Linton	Anguilla chrysypa	435
	Brevoortia tyrannus	440
	Clupea harengus	437
	Cynoscion regalis	460
	Decapterus macarellus	449
	Leptocephalus conger	436
	Limanda ferruginea	485
	Menticirrus saxatilis	462
	Merluccius bilinearis	474
	Paralichthys dentatus	482
	Pomatomus saltatrix	451
	Pomolobus pseudoharengus	439
	Pseudopleuronectes americanus	486
	Sarda sarda	446
	Scomber scombrus	445
	Spheroides maculatus	464
	Stenotomus chrysops	458
	Tautogolabrus adspersus	462
Distomes (young)	Achirus fasciatus	487
Distomum sp	Anguilla chrysypa	435
Distomum sp	Enchelyopus cimbrius	479
Distomum sp	Fundulus heteroclitus	442
Distomum sp	Gasterosteus bispinosus	443
Distomum sp	Lagocephalus lævigatus	464
Distomum sp	Limanda ferruginea	485
Distomum sp	Menidia notata	444
Distomum sp. (appendiculate)	Menticirrus saxatilis	462
Distomes	Opsanus tau	469
Distomum sp	Paralichthys dentatus	482
Distomum sp	Pomatomus saltatrix	451
Distomum sp	Prionotus carolinus	471
Distomum sp. in cysts	Pseudopleuronectes americanus	486
Distomum sp	Rhombus triacanthus	454
Distomum (Kölikeria) sp	Scomberomorus maculatus	464
Distomum sp	Stenotomus chrysops	458
Distomum sp	Stolephorus brownii	440
Distomes encysted in skin	Tautoga onitis	463
Distomes encysted in skin	Tautogolabrus adspersus	462
Encysted ova in liver	Morone americana	456
Gasterostomum arcuatum Linton	Sarda sarda	446
	Carcharinus obscurus	427
Gasterostomum ovatum Linton	Lobotes surinamensis	457
Gasterostomum sp	Scomberomorus maculatus	447
Gasterostomum sp	Tylosurus marinus	442
Monostomum orbiculare Rudolphi. See Gasterostomum ovatum.		
Monostomum vitual-edwardsii sp. nov	Opsanus tau	470
Monostomum sp	Pomolobus pseudoharengus	439

PROTOZOA.

Myxobolus lintoni Gurley	Cyprinodon variegatus	442
Sporocyst	Rhombus triacanthus	455
Sporozoa	Clupea harengus	438
	Pomolobus pseudoharengus	439
Sporozoa	Pseudopleuronectes americanus	487
Sporozoa (?)	Dasyatis centrura	433

RHYNCHOBDELLIDA.

Branchiobdella ravenellii Diesing	Dasyatis centrura	433
Pontobdella rapax Verrill	Paralichthys dentatus	483
	Stenotomus chrysops	459

EUCOPEPODA.

Parasitic copepod	Cynoscion regalis	461
Philichthys xiphiæ Steenstrup	Xiphias gladius	448

Analytical key to the genera of Cestodes mentioned in this report.

1.	Scolex spherical or subspherical with cup-like bothria	3.
2.	Scolex of various shapes, but unlike 1	4.
3.	Scolex simple	*Tænia.*
	Scolex with retractile appendages in front	*Parataenia.*
4.	Scolex mushroom shape without bothria	*Discocephalum.*
	Scolex provided with bothria	5.
5.	Bothria two	*Dibothrium.*
	Bothria four	6.
6.	Bothria united into a discoidal or subglobular mass	7.
	Bothria distinct	8.
7.	Scolex discoidal	*Lecanicephalum.*
	Scolex subglobular with subglobular myzorhynchus	*Tylocephalum.*
8.	Bothria unarmed	9.
	Bothria armed	19.
9.	Bothria without auxiliary suckers	10.
	Bothria with auxiliary suckers	13.
10.	Bothria with costæ	11.
	Bothria without costæ	12.
11.	Scolex with myzorhynchus	*Echeneibothrium.*
	Scolex without distinct myzorhynchus	*Rhinebothrium.*
12.	Bothria in pairs, fan shape, with frilled or lobed borders	*Spongiobothrium.*
	Bothria cruciform with entire margins	*Anthobothrium.*
13.	Two auxiliary suckers on each bothrium	[1] *Orygmatobothrium.*
	One auxiliary sucker on each bothrium	14.
14.	Auxiliary suckers relatively large, formed from anterior part of bothrium	15.
	Auxiliary suckers small, circular	16.
15.	Auxiliary suckers entire, scolex with terminal haustellum	*Monorygma.*
	Auxiliary suckers horseshoe shape, anterior ends of bothria partly retractile	*Calyptrobothrium.*
16.	Bothria in pairs	17.
	Bothria cruciform	18.
17.	Scolex with terminal muscular disk	*New Cestode from Tile-fish.*
	Scolex without terminal muscular disk	*Phyllobothrium.*
18.	Bothria slender pedicelled, with crenulate borders	*Anthocephalum.*
	Bothria short pedicelled, border not crenulate	*Crossobothrium.*
19.	Bothria armed with hooks	20.
	Bothria provided with retractile spiny proboscides	25.
20.	Hooks inconspicuous, of densely fibrous structure	*Thysanocephalum.*
	Hooks chitinous, structureless	21.
21.	Hooks simple	22.
	Hooks compound	23.
22.	Bothria without auxiliary suckers	*Onchobothrium.*
	Bothria with auxiliary suckers, anterior to hooks	*Calliobothrium.*
23.	Scolex flattened, bothria in pairs, hooks in pairs united by a chitinous bar	*Platybothrium.*
	Bothria cruciform	24.
24.	Hooks with two prongs each, bothria costate	*Acanthobothrium.*
	Hooks with three prongs each, bothria loculate at posterior end	*Phoreiobothrium.*
25.	Bothria two	*Rhynchobothrium.*
	Bothria four	26.
26.	Bothria each with an auxiliary pit	*Otobothrium.*
	Bothria without an auxiliary pit	27.
27.	Bothria lateral	*Tetrarhynchus.*
	Bothria terminal	*Synbothrium.*

Analytical key to the Distoma mentioned in this report.

	Body unarmed	1.
	Body armed with spines	6.
1.	With a more or less retractile caudal appendage	Table I.
	Without a retractile caudal appendage	2.
2.	Sexes separate. See *Distomum* (*Köllikeria*) sp. from cysts in *Scomberomorus maculatus.*	
	Sexes united, hermaphroditic	3.
3.	Head provided with lobes (*Bunodera*). See *Distomum auriculatum.*	
	Head without lobes	4.
4.	Forks of intestine with lateral folds or branches	Table IV.
	Forks of intestine simple	5.
5.	Œsophagus none or very short	Table II.
	Œsophagus distinct	Table III.
6.	Mouth armed with spines	Table V.
	Mouth unarmed	7.
7.	Forks of intestine simple, testes normally two	Table VI.
	Each fork with an anteriorly directed branch from near base of œsophagus, testes numerous [*Plearche*]	*Distomum polyorchis.*

[1] The species referred in early papers to *Orygmatobothrium angustum* has been placed in this paper in the genus *Crossobothrium.*

TABLE I.—*Appendiculate distomes* [*Hemiurus* (*Apoblema*)].

Species.	Suckers.	Vitellaria.	Testes.	Ovary.	Size (millimeters).	Ova (microns).	Intestine.	Other characters and remarks.
D. ocreatum Molin.	About equal	Two; one subglobular, the other trilobed; transverse, middle of body.	Two; small, median, oblique, behind ventral sucker.	Globose; remote from testes at anterior margin of vitellaria.	Variable, 1.26 to 3.66.	25x14	Forks extending into appendix.	Seminal vesicle at anterior edge of ventral sucker.
D. appendiculatum Rudolphi.	Ventral about twice diameter of oral.	Two; small, ventral, right subglobular, left somewhat trilobed, toward posterior.	Two; small, oblique near ventral sucker.	Subglobular, at anterior edge of vitellaria.	1.13	27x14	Forks not extending into appendix.	Seminal vesicle behind ventral sucker. Body usually with fine transverse striæ.
D. læve Linton	Ventral greatly exceeding oral.	Two; subglobular a little way back of middle, transverse.	Two; small, transverse at posterior edge of ventral sucker.	Remote from testes at anterior edge of vitellaria.	1.5 to 3.5	26x12	do	Body somewhat fusiform, smooth, cirrus pouch anterior to ventral sucker.
D monticellii Linton	Ventral 3 to 5 times diameter of oral.	Lobed, toward posterior end.	Two; globular, oblique halfway between ventral sucker and ovary.	Globular, at anterior edge of vitellaria.	5.5	25x14 (life); 18x11 (alc.)	Forks long	Body slender, often with transverse rugæ.
D. grandiporum Rudolphi	Ventral 2½ to 3 times oral, or more.	Two; large, immediately behind ovary.	Two; globose, behind ventral sucker.	Large, globose, posteriorly placed.	5.5	17x9	Forks irregular in outline entering appendix.	Seminal vesicle in front of ventral sucker.
D. gulosum sp. nov.	Nearly equal	Tubular, near middle of body, about 6 showing in section.	Two, smallish, subglobular, end to end behind seminal vesicle.	Globular, a short distance behind testes.	10 (life); 7.5 (alc.).	17x10	Forks extending into the long, slender appendix.	Body slender, crossed anteriorly by fine striæ; pharynx tubular, about as long as oral sucker.
D. tornatum Rudolphi.	Ventral much larger than oral.	Tubular, surrounding ovary, extending to testes.	Two, smaller than and a short distance behind ventral sucker.	Subglobular, a short distance back of testes.	13.75, usually about 10.	22x17 (Coryphæna); 17x12 (Menidia).	Forks extending into appendix.	Integument semi-transparent; genitalia conspicuous, white, yellow, brown, etc.
D. rufoviride Rudolphi.	Ventral twice diameter of oral.	Two; multifid, on left side	Two; large, round at each side behind ventral sucker.		5 to 9		Forks not reaching appendix.	Specimens described (**4**, p. 575) appear to belong to D. tornatum, or near it.
D. sp. from menticirrus saxatilis.	Ventral about twice diameter of oral.	Two; slender, convoluted, tubular to right and left of ovary.	Two, large, globular, transverse behind ventral sucker.	Globular, smaller than testes, median close behind testes.	3	35x21	Forks long, reaching but not entering appendix.	Body ovate-elliptical, depressed; appendix short.

TABLE II.—*Ecaudate distomes with œsophagus very short or none.*

Species.	Suckers.	Vitellaria.	Testes.	Ovary.	Size (millimeters).	Ova (microns).	Intestine.	Other characters and remarks.
D. vibex Linton ...	Ventral much larger than oral.	Lateral and posterior extending forward to ventral sucker.	Two: lateral behind ventral sucker and in front of folds of uterus.	Subglobular, in front of testes, dorsal.	1.25 to 6	59x29	Forks extending to posterior end.	Body thick, convex above, neck concave beneath; genital aperture behind pharynx.
D. fœcundum Linton.	Ventral much larger than oral, aperture transverse.	Dorso-lateral from posterior end to ventral sucker, not abundant.	Two; transverse near posterior end.	Dorsal to and projecting in front of testes, transverse diameter greatest.	2.75	34x17: 41x17; very numerous.	.....do	Body bluntly rounded in front, squarish posteriorly, thick.
D. sp. from Raja lævis (figs. 224, 225).	Ventral much larger than oral, aperture longitudinal.	Two lateral clusters of small dark bodies beside the testes.	Two: lateral, side by side, near posterior end.	Smaller than testes, in front of them, to the right, apparently two-lobed.	7.5	86x45: few	....	General habit of body much as in D. fœcundum.
D. sp. from Gasterosteus bispinosus. Probably belongs here (fig. 226).	Ventral twice the diameter of oral.	Behind ventral sucker, lateral and at posterior end.	Two; lateral, near posterior end.	....	1	80x35	....	
D. bothryophoron Olsson.	Ventral about twice the diameter of oral.	A single 6 or 7 lobed mass, lateral toward posterior end.	Two; rather small, elliptical, immediately behind ventral sucker.	On left side in front of vitellaria.	.87 .8	20x13; very numerous. 17x10: very numerous.	Forks extending to posterior end.	Body conspicuously short—fusiform.
D. sp. B (*a*) from Opsanus tau. (fig. 203).	Ventral larger than oral.	Scattered masses, posterior and marginal not quite to ventral sucker.	Two; globular, median at about posterior third.	Globular, at anterior edge of front testis, to right.	1.21	....	Forks thin-walled, inflated, extending to posterior end.	See text.
D. sp. B (*b*) from Opsanus tau. (fig. 204).	.....do	Crowded granular masses, posterior and marginal to pharynx.	Two; on median line at posterior third, broader than long.	.....do	.88	45x24	Forks slender, thick-walled, to posterior end.	See text.

TABLE III.—*Ecaudate distomes with distinct œsophagus.*

Species.	Suckers.	Vitellaria.	Testes.	Ovary.	Size (millimeters).	Ova (microns).	Intestine.	Other characters and remarks.
D. simplex Rudolphi.	Ventral twice diameter of oral.	Numerous, relatively large, globose, from posterior laterally to ventral sucker.	Two; large, median, toward posterior end.	In front of anterior testis, somewhat three-lobed on posterior edge.	3 to 9	80x40	Forks extending to posterior end.	Œsophagus equal to pharynx.
D. vitellosum Linton.	Ventral larger—as much as three times diameter of oral.	Numerous, large, subangular, posterior and lateral to ventral sucker.	Two; large, median, approximate, near posterior end.	In front of anterior testis, a little to right.	1.4	50x30	....do	Œsophagus usually longer than pharynx; genital aperture in front of the ventral sucker to left, aperture of ventral sucker, undulate or lobed.
D. pudens Linton.	Ventral usually somewhat larger than oral.	Numerous, small bodies, posterior and lateral to pharynx.	Two; rather large, median, approximate, toward posterior end.	Globular, much smaller than testes, at anterior edge of front testes, to right.	3.7	55x35	Forks extending to posterior end of body.	Œsophagus shorter than pharynx; genital aperture in front of ventral sucker, median.
D. pallens Rudolphi.	Ventral about twice diameter of oral.	Numerous, globular minute; lateral in posterior half of body.	Two; large, elliptical, median, behind folds of uterus.	Globular, in front of testes.	3.1	67x31	"Forks extending to posterior end."	"Body oblong, subdepressed, rounded posteriorly."
D. globiporum Rudolphi.	About equal	Fill posterior part of body back of testes; nearly to ventral sucker.	Two; median, about middle of body.	Close behind cirrus pouch, to right, smaller than testes.	4.35	71x50	Forks extend to posterior end.	Agrees with description of this species, except that œsophagus is not longer than pharynx.
D. sp. from Paralichthys dentatus (fig. 228) and D. sp. from Rhombus triacanthus (fig. 229).	....do	At posterior end, and lateral as far as ventral sucker or in front of it.	Two; subglobular, median, approximate, toward posterior.	Globular, in front of testis, on median line, or a little to right.	1.19 1.46	52x34 75x58	....do	First resembles D. pudens; œsophagus longer than pharynx in both.
D. sp. from Menidia notata.	Ventral about twice diameter of oral.				1	Small, same as D. bothryophoron.	....do	Body fusiform, like D. bothryophoron, but neck more slender.
Distomum sp. from Limanda ferruginea (figs. 235–238).	Ventral larger than oral.	Lateral from testes to pharynx.	Two; rather large, diagonal at posterior end.	Smaller than testes, subglobular or slightly two-lobed in front of anterior testes, to right.	2.57	65x41	Forks extend to ovary.	Body, fusiform.
Distomum fragile Linton.	Ventral a little larger than oral.	Very abundant at posterior end, lateral and dorsal to and in front of ventral sucker.	Two; median, approximate, near posterior end.	Subglobular, immed ately in front of anterior testis, a little to the right.	1.78 to 4.2	69x38	Forks extending nearly to posterior end.	Body slender, fusiform neck elongated; œsophagus much longer than pharynx.

TABLE IV.—*Unarmed distomes with intestinal rami branched or saccate.*

Species.	Suckers.	Vitellaria.	Testes.	Ovary.	Size (millimeters).	Ova (microns).	Intestine.	Other characters and remarks.
D. macrocotyle Diesing.	Ventral twice diameter of oral.	In neck and as far back as ovary.	Two; oval, ventral, one behind the other.	Back of posterior testes, halfway between ventral sucker and posterior end.	14 (alcoholic).	26x17	Anastomosing vessels in front saccate and dark colored in body, extending to tail.	Body round, curved, linear-fusiform, neck conical, reflexed, genital aperture near oral sucker.
D. veliporum Creplin.	Ventral much larger than oral.	Lateral not extending to posterior end of intestine.	Two; median approximate, in front of forks of excretory vessels behind folds of uterus.	In front of testes, a little to right.	20, 50 to 80	76x52	....	Body depressed, long, transversely roughened, genital aperture at posterior margin of pharynx.
D. clavatum Rudolphi.	Ventral more than twice diameter of oral.	In middle of body, apparently in small tubular or thread-like folds.	Two; close behind ventral sucker.	Immediately following testis.	18 (alcoholic).	34x24	Anastomosing vessels in neck, saccate and dark colored in body, to tail.	Body cylindrical, posteriorly thickened; genital aperture midway between suckers.
D. lageniforme Linton.	Ventral much larger than oral.	....	....	....	20 (life); 7.5 (life, contracted).	....	....	Genital aperture just back of mouth; body depressed, contracting to subglobular shape; neck concave below.

TABLE V.—*Distomes with body more or less covered with spines and mouth armed with spines.*

Species.	Suckers.	Vitellaria.	Testes.	Ovary.	Size (millimeters).	Ova (microns).	Intestine.	Other characters and remarks.
Distomum tenue Linton.	Ventral larger than oral.	Abundant, peripheral in posterior region, lateral to ventral sucker.	Two; subglobular, median, toward posterior end of body.	Globular, in front of testes.	2.9	88x44	Forks extending nearly to posterior end.	Pharynx large, remote from head, no œsophagus; double row of 21 spines each around mouth.
Distomum tenue var. tenuissime Linton.	Ventral nearly twice oral.	Voluminous in posterior two-thirds of body, obscuring other organs.	Two; rather large in posterior third of body.	Subglobular, in front of testes.	4.5	93x58. 40x26	....	Slender, linear, spines evanescent both on body and around mouth.
Distomum dentatum Linton.	Ventral much larger than oral.	Very abundant, as in D. tenue, but extending into neck.	Two; large, median, approximate, at posterior third of body.	Subglobular, triangular in outline, close in front of anterior testis.	1.87	70x30	Forks extend to posterior end of body.	Relatively broader, more appressed, and smaller than D. tenue; 24 spines in each oral circle.
Distomum valde-inflatum Stossich.	Ventral larger than oral.	....	....	....	....	....	....	Only immature forms in cysts seen.

TABLE VI.—*Distomes with bodies more or less covered with spines, mouth unarmed.*

Species.	Suckers.	Vitellaria.	Testes.	Ovary.	Size (mm.).	Ova (microns).	Intestine.	Other characters and remarks.
Distomum contortum Rudolphi.	Ventral larger than oral.	Lateral and dorsal, from posterior end to testes.	Two; approximate, slightly back of ventral sucker, a little to left.	Behind posterior testis, to the right and dorsal.	12 (alcoholic).	36x20, 33x20, 30x20.	Forks thick walled, extending to posterior end.	Spines thick and tuberculate.
Distomum nigroflavum Rudolphi.	Ventral larger than oral, pedicellate.	Slender, thread-like, convoluted, betw. ovary and ventral sucker.	Two; elliptical, about middle of post-acetabular region.	A short distance behind posterior testis.	35 (alcoholic).	30x20	Forks dark colored, extending to posterior end.	Spines deciduous.
Distomum foliatum Linton.	Ventral larger than oral, pedicellate, foliate.	From ovary nearly to oral sucker abundant in neck.	Two; oblong, near middle of post-acetabular region.	A short distance back of posterior testis.	16 (alcoholic).	32x22	Forks irreg., dark colored, reaching posterior end.	Dorsum of neck with several transverse crests.
Distomum nitens Linton.	Ventral larger than oral.	Rather large globular masses, lateral along middle of body.	Two; rather large, transverse, about middle of body.	Behind ventral sucker, globular.	5.5 (alcoholic).	33x18	Forks long..........	Cirrus-pouch in front of ventral sucker.
Distomum rachion Cobbold.	Oral larger than ventral.	Posterior and lateral to ventral sucker.	Two; globular, median, a little back of middle.	Globular, in front of anterior testis.	3........	70x40	Forks reaching to posterior end.	Flat scale-like spines dense on neck, slender and scattering back of ventral sucker.
Distomum areolatum Rudolphi.	Oral a little larger than ventral.	Posterior and lateral to and a little in front of ventral sucker.	Two: rather large, transverse, near middle of body.	Subglobular, in front of testes, to the left.	1.3 (alcoholic).	110x70	Forks extending nearly to posterior end.	There is a vitelline reservoir between testes and ovary.
Distomum pyriforme Linton.	About equal...	Filling body posterior and lateral to and in front of ventral sucker.	Two: median, approximate, near posterior end.	Small, globular, to right, in front of testes.	0.16 to 0.57.	55x31	Forks reaching posterior end.	Very variable in shape.
Distomum sp. from Stenotomus chrysops (7, p. 296, figs. 72–75).	About equal...	Marginal from posterior end to ventral sucker.	Two; large, median, back of middle, broader than long.	Subglobular, close in front of anterior testis.	0.62 to 1..	76x34, 76x52.	Forks spacious, extending to posterior end.	See also Distomum sp. (4, p. 537. LIII, 1, 2).
Distomum sp. from Fundulus heteroclitus (fig. 230).	Nearly equal ..	Posterior and lateral to ventral sucker.	Two: globose, median, approximate, back of middle.	Globular, between anterior testis and ventral sucker to right.	2.72 (formol).	110x70	Forks extending nearly to posterior end.	Body white, translucent, very minutely spinose, spines very easily overlooked.
Distomum sp. from Enchelyopus cimbrius.	Ventral somewhat larger than oral.	Generally distributed back of ventral sucker, especially at posterior end.	Two; large, median, in posterior half of body, not approximate.	Globular, close in front of anterior testis.	3.62 (alcoholic).	70x40	Forks extend to near posterior end.	Body, elongated, linear, depressed, with minute, flat spines; œsophagus equals pharynx.
Distomum sp. from Opsanus tau (Species A, figs. 201, 202).	About equal...	Abundant; posterior and lateral to ventral sucker in larger, to pharynx in smaller.	Two; median and middle, anterior subglobular, posterior somewhat three-lobed.	Subglobular, near posterior edge of ventral sucker to the left.	3.6, 1.1...	100x70	Forks extend nearly to posterior end.	Minute, scattering, scale-like spines easily overlooked.
Distomum sp. from Stolephorus brownii (figs. 195, 196).	Ventral larger than oral.	Two, subglobular, dorsal and posterior to ventral sucker.	Not distinctly seen, but near vitellaria, apparently behind ovary.	Globular, about on level with ventral sucker, near vitellaria, not distinctly seen.	1.71	21x11, filling median and posterior of body.	Could not be traced back of ventral sucker in these specimens.	Preserved specimens fusiform; pharynx globose, remote from the mouth, œsophagus longer than pharynx.
Distomum hispidum Abilgaard.	Ventral more than twice oral.	Posterior and lateral to ventral sucker.	Two; median, anterior globose, posterior elliptical.	Small, globular, median, in front of anterior testis.	3 to 6	86x55	Forks extending to posterior end not made out in these specimens.	Neck clothed with coarse spines, body with smaller spines.

Index of fishes mentioned in this report.

Index of fishes mentioned in this report—Continued.

LIST OF PAPERS REFERRED TO BY NUMBER IN THE TEXT.

1. Notes on Entozoa of Marine Fishes of New England, with descriptions of several new species. Report of Commissioner of Fish and Fisheries for 1886. Washington, 1889.

2. Notes on Entozoa of Marine Fishes of New England. Part II. Report of Commissioner of Fish and Fisheries for 1887. Washington, 1890.

3. Notes on Entozoa of Marine Fishes. Part III, Acanthocephala. Report of Commissioner of Fish and Fisheries for 1888. Washington, 1891.

4. Notes on Larval Cestode Parasites of Fishes. Proceedings of United States National Museum. Vol. XIX. Washington, 1897.

5. Notes on Cestode Parasites of Fishes. Proceedings of United States National Museum. Vol. XX. Washington, 1897.

6. Notes on Trematode Parasites of Fishes. Proceedings of United States National Museum. Vol. XX. Washington, 1897.

7. Fish Parasites collected at Woods Hole in 1898. Bulletin of the United States Fish Commission for 1899. Washington, 1900.

SUMMARY OF FISH PARASITES ARRANGED UNDER THEIR HOSTS.

Mustelus canis, *Smooth Dog-fish.*

FOOD.

The alimentary canals usually contain crabs (*Panopeus*, *Platyonichus*, *Cancer*, *Libinia*, etc.). Squid, annelids, and fish have also been noted.

NEMATODES.

1. *Ascaris* sp. [Pl. IX, fig. 90.]

Two imperfect specimens in U. S. National Museum collection apparently removed from peritoneal capsules. Dimensions in millimeters: Length, 23; diameter of head, 0.12; maximum diameter a little back of middle, 0.45; distance of anal aperture from posterior end, 0.15. Head with three short lips, two bluntly angled, the third rounded. Body transversely rugose; posterior end bluntly rounded with a mucronate tip which is conical and wrinkled.

CESTODES.

2. *Dibothrium* sp. Spiral valve. **5**, p. 433.
3. *Calliobothrium verticillatum* Rudolphi. Spiral valve. **1**, pp. 476–479, pl. IV, figs. 1–8. **2**, pp. 810–812. **5**, p. 447, pl. XXXIV, figs. 6, 7. **7**, p. 270. Aug. 14, 1899; from two hosts, 25 large, 9 small. Aug. 28, 1899; from one host, 8. July 18, 1900; from one host, 63.

Ripe proglottides noticed on one occasion upon which apertures for discharge of ova had developed. These were arranged along the median line of one of the flat surfaces and numbered about five in most cases, although as many as eight were counted. When the proglottis was viewed from the margin these apertures were seen to be slightly projecting. [Pl. XXVI, fig. 289, *a* and *b*.]

4. *Calliobothrium eschrichtii* Beneden. Spiral valve. **2**, pp. 812–816, pl. VII, figs. 5–12. **5**, p. 447. Aug. 14, 1899, 1.
5. *Rhynchobothrium lomentaceum* Diesing. Spiral valve. **2**, pp. 845–847, pl. XIII, figs. 1–3.
6. *Rynchobothrium bulbifer* Linton. Spiral valve. **1** [*R. tenuicolle* Rudolphi], pp. 486–488, pl. V, figs. 17, 18. **2**, pp. 825–829, pl. X, figs. 8, 9, and pl. XI, figs. 1, 2. **5**, p. 448. **7**, p. 270. July 26, 1899; from two hosts, 22. Aug. 14, 1899; from two hosts, 12. Aug. 28, 1899; from one host, 3.
7. *Rhynchobothrium tumidulum* Linton. Spiral valve. **2**, pp. 829–832, pl. XI, figs, 3–11. **5**, p. 448. **7**, p. 270. July 18, 1900; from one host, 6.
8. *Rhynchobothrium heterospine* Linton. Spiral valve. **2**, pp. 839–840, pl. XII, figs. 3–5.
9. *Rhynchobothrium* sp. Blastocyst, stomach. **4**, p. 798, pl. LXIV, fig. 2.
10. *Tetrarhynchus* sp. Cysts, stomach-wall. **4**, p. 809, pl. LXVI, figs. 6, 7.
11. *Synbothrium filicolle* Linton. Cysts, stomach-wall. **4**, pp. 815, 819, 820, pl. LXVIII, fig. 9.

Galeocerdo tigrinus (*Galeocerdo maculatus*), *Tiger Shark.*

FOOD.

The stomach may contain a great variety of objects (**7**, pp. 270–271), but fish, univalve mollusks, and squid probably constitute the principal food. The single specimen examined in 1899 had been kept in confinement for two or three weeks and had nothing in the alimentary canal except two opercula of the winkle (*Sycotypus canaliculatus*), feathers of a flicker, and some green seaweed in the intestine. In the specimens examined in 1887 fragments of menhaden, bonito, and opercula of the winkle were noted.

NEMATODES.

1. *Ascaris brevicapitata* sp nov.; stomach. [Pl. III, figs. 19–22.]

Four specimens collected August 3, 1889, and a single specimen belonging to the National Museum collection are of nearly uniform diameter for the greater part of their length, but are attenuate anteriorly, particularly so for about 5 mm. at the anterior end; greatest diameter near posterior end, which is recurved. Longest female 102 mm. in length and 1 mm. in diameter; body marked with regular annulations about 0.008 mm. in length; œsophagus linear; spicules of male long and slender; about 8 postanal and 30 or more preanal papillæ on each side; jaws very short and provided with papillæ. Dimensions of a male in millimeters: Length, 70; diameter of head, 0.17; length of head, 0.08; diameter of body one mm. back of head 0.56, one mm. from posterior end 0.75, at anal aperture 0.37, maximum diameter 1.25; distance of anal aperture from posterior end, 0.51.

2. *Acanthocheilus nidifex* Linton. Stomach. **7**, pp. 270, 271, 303, pl. XXXIII, figs. 116–119. 1899, from one host, 3 in pits of mucous membrane of stomach. Ova, kept in sea water, which on August 20 showed only early stages of cell division, on August 23 contained active embryos.

CESTODES.

3. *Orygmatobothrium paulum* Linton. Spiral valve. **5**, p. 444, pl. XXXIII, figs. 7, 8.
4. *Thysanocephalum crispum* Linton. Spiral valve. **1** [*Phyllobothrium thysanocephalum*], pp. 464–468, pl. II, figs. 1–12. **2**, pp. 823–824. **3**, pp. 543–556, pls. LXI–LXVII. **5**, p. 448. **7**, p. 271. See also **4**, p. 792, pl. LXII, figs. 10–11, for mention of larva from the squid. Aug. 19, 1899; from one host, 113, large and small.
5. *Monorygma* sp. Spiral valve. **7**, p. 271. See No. 3 under *Isurus dekayi.*
6. *Tetrarhynchus bicolor* Bartels. Stomach. **4**, p. 813–815, pl. LXVIII, figs. 1–6. **7**, p. 271. Aug. 19, 1899, several attached to and penetrating the stomach wall.

Carcharinus milberti, *Blue Shark.*

(Incorrectly referred to *Prionace glauca* in paper cited below.)

FOOD.

Two small specimens, 4½ feet long, taken August 5, 1889. Stomachs contained half-digested fish (bonito). A specimen taken off Gay Head by the schooner *Grampus*, July 30, 1900, and examined by Mr. C. W. Stone, was reported to have had fish of different kinds in the stomach, one of which was a flounder. This specimen measured 9½ feet.

NEMATODES.

1. *Immature nematodes.* Spiral valve. Embryonic cuticle still partly adhering. Specimens probably introduced with food, July 30, 1900.

CESTODES.

2. *Anthobothrium laciniatum* Linton. Spiral valve. **2**, pp. 754–759, pl. III, figs. 10–13; pl. IV, figs. 1–3. **5**, p. 439. July 30, 1900, 4, very small.
3. *Crossobothrium angustum* Linton. [*Orygmatobothrium angustum* Linton.] Spiral valve. **1**, pp. 468–469, pl. III, figs. 1–3. **2**, pp. 796–799, pl. VII, fig. 3. **5**, p. 443.
4. *Monorygma* sp. Spiral valve. July 30, 1900, 27, small. See remarks on No. 3, under *Isurus dekayi.*
5. *Phoreiobothrium lasium* Linton. **1**, pp. 474–476, pl. IV, figs. 24–29. **2**, pp. 819–820. **5**, p. 447. **7**, pp. 272–273.
6. *Platybothrium parvum* sp. nov. Spiral valve, July 30, 1900, 253.

Probably the same species mentioned in **7**, p. 300, pl. XXXII, figs. 98, 99. The hooks are identical and should have been selected as a generic character. The bothria are provided with two costæ on the posterior end and an auxiliary sucker in front of hooks. Neck elongated and densely spinose. The bothria in these specimens differ from any of the genus seen before in that they are trough-shape, the head thus bearing a strong superficial resemblance to *Phoreiobothrium.* The ripe segments are elliptical and loosely attached, making a moniliform chain. Longest specimens, 10 to 15 mm.

Dimensions of one of the larger specimens in millimeters: Length, 15; length of head, 0.54; breadth of head in front, 0.41; diameter of neck immediately behind the head, 0.11; length of last segment, 0.67; breadth, 0.47. The first distinct segments began about 5 mm. back of head.

7. *Rhynchobothrium tenuispine* Linton. Spiral valve. **2**, pp. 837–838, pl. XII, figs. 1, 2. **5**, pp. 448–449, pl. XXXIV, fig. 8.

Carcharinus obscurus (*Carcharias obscurus*), *Dusky Shark.*

FOOD.

Fish, among which menhaden and squeteague have been recognized. The stomach of a specimen examined August 1, 1899, contained a large quantity of oil in globular masses about the size of average peas. All the specimens examined in 1899 and 1900 were small—4½ to 5 feet.

ACANTHOCEPHALA.

1. *Echinorhynchus agilis* Rudolphi. Spiral valve. **1**, pp. 490–492, pl. V, figs. 1–6.

CESTODES.

2. *Discocephalum pileatum* Linton. Spiral valve. **2,** pp. 781–787, pl. x, figs. 1–7. **7,** p. 272. Rare; heads buried in mucous membrane of spiral valve; difficult to remove without breaking.
3. *Anthobothrium laciniatum* Linton. Spiral valve. **2,** pp. 754–759, pl. III, figs. 10–13, and pl. IV, figs. 1–3. **7,** p. 272. July 17, 1899; from one host, 1. July 22, 1899; from one host, 1. Aug. 1, 1899; from one host, 150. Aug. 21, 1899; from one host, 53. Aug. 25, 1899; from one host, numerous. July 20, 1900; from one host, 7.
4. *Crossobothrium angustum* Linton. [*Orygmatobothrium angustum* Linton.] Spiral valve. **1,** pp. 468–469, pl. III, figs. 1–3. **2,** pp. 796–799, pl. VII, fig. 3. **7,** p. 272. July 22, 1899; from one host, 11. Aug. 1, 1899; from one host, 12. Aug. 25, 1899; from one host, 3. July 20, 1900; from one host, 24.

Among the specimens collected in 1900 two types were represented, one elongated, very slender, almost hair-like, attaining a length of 30 mm. with elongated and squarish segments; the other much shorter with moniliform segments beginning 10 mm. back of head. The generic name *Orygmatobothrium* must be discontinued for this form. It and *Crossobothrium*, probably, are generically the same—i. e., bothria cruciformly arranged, each with a single auxiliary acetabulum. The latter does not resemble anterior end of bothrium of *Monorygma*. Of frequent occurrence, sometimes abundant.

5. *Phoreiobothrium lasium* Linton. Spiral valve. **1,** pp. 474–476, pl. IV, figs. 24–29. **2,** pp. 819–820. **7,** p. 272. Aug. 11, 1899; from one host, 50. Aug. 21, 1899; from one host, 146. Aug. 25, 1899; from one host, numerous. July 20, 1900; from one host, 3.
6. *Phoreiobothrium triloculatum* sp. nov. Spiral valve. [Pl. XXVI, fig. 292.] Aug. 11, 1899; from one host, 10. Aug. 25, 1899; from one host, few. July 20, 1900; from one host, 16.

Head larger than that of *P. lasium*. The most striking difference is in the posterior ends of bothria, each of which has three loculi (arranged in a transverse row) instead of the numerous small loculi characteristic of *P. lasium*. Dimensions of a specimen in sea water, in millimeters: Length, 25; length of head, 0.71; breadth of head, 0.76; thickness of head, 0.63; breadth of neck, 0.36; thickness of neck, 0.13; distance to first distinct segment, 4.5; length of last segment, 3; breadth, 0.78.

7. *Platybothrium cervinum* Linton. Spiral valve. **2,** pp. 820–823, pl. VIII, figs. 8–10, and pl. IX, fig. 1.
8. *Tetrarhynchus bisulcatus* Linton. **1** [*Rhynchobothrium bisulcatum*], pp. 479–486, pl. IV, figs. 9–23. **2,** pp. 857–861, pl. XIV, figs. 10–12, and pl. XV, fig. 1. **5,** p. 452. **7,** p. 272. Sometimes very abundant in the pylorus, the heads often embedded in the mucous membrane.
9. *Tetrarhynchus bicolor* Bartels. **4,** pp. 813–815, pl. LXVIII, figs. 5, 6.
10. *Tetrarhynchus* sp. Cysts, stomach wall. **4,** pp. 807–808.
11. Cysts containing degenerate connective tissue sometimes found in the walls of alimentary tract.

TREMATODES.

12. *Gasterostomum arcuatum* Linton. Spiral valve. July 22, 1899; from one host, 5 larger, with ova, 3 smaller.

Length of larger, 3.29 mm., very changeable, especially the anterior part. Translucent white except back of middle where the color is yellow on account of the ova. The alcoholic specimens are arcuate; their slender necks densely clothed with flat spines, which continue to the posterior end. On the posterior half of the body they are less dense and arranged in transverse series. Ova 0.021 and 0.014 mm. in the two principal diameters. These specimens agree with those from the bonito in all essential characters. The only point of difference noted is that the number of vitellaria does not appear to be quite so definite in these as in the specimens from the bonito. Their arrangement, however, is the same, and the number does not vary greatly from that given in the original description, viz, 32. See **7,** pp. 297–298, pl. XLI, figs. 85–90.

Sphyrna zygæna, *Hammerhead*.

FOOD.

Fish and squid.

NEMATODES.

1. *Spiroptera pectinifer* sp. nov. Stomach. [Pl. XV, figs. 197, 198; pl. XVI, fig. 199.]

Two nematodes, a male and a female, collected July 18, 1887, are here recorded. Mouth terminal, aperture round, two small lateral papillæ on head. Tail in each coiled in a close spiral. Spicules in

male apparently equal. Anal aperture transverse with a chitinous toothed plate on its posterior border. Preanal papillæ, as seen on left side, about 24, arranged somewhat in groups of three; on right side they appear to be fewer and larger; postanal papillæ, 10 seen on left side and 7 on right, with 6 nearly median near the tip. Dimensions in millimeters: Male, length, 16.5; diameter of head 0.11, 1 mm. from anterior end 0.36, maximum 0.56, 1 mm. from posterior end 0.47, at anal aperture 0.27; distance of anal aperture from posterior end, 0.27; length of œsophagus, 1.8. Female, length, 30; diameter of head 0.13, 1 mm. from anterior end 0.42, maximum 0.86, 1 mm. from posterior end 0.71, at anal aperture 0.28; distance of anal aperture from posterior end, 0.28; length of œsophagus, 2.

2. *Ichthyonema* sp.

From liver, collected by Dr. Howard Ayers, August 17, 1889. The specimen is the posterior end of a female, 108 mm. in length and 0.7 mm. in diameter and tapering at posterior end.

3. *Immature nematodes.* [Pl. XIV, figs. 183–184.]

Fragment from intestine, July 28, 1886, evidently introduced with food; length, 15 mm.; diameter, 0.45 mm.; still inclosed in hyaline embryonic cuticle; posterior end bluntly rounded; diameter nearly uniform, irregularly interrupted by indentations. July 31, 1899; small fragment from intestine.

CESTODES.

4. *Anthobothrium laciniatum* Linton. Spiral valve. July 31, 1899; from one host, 4. Not recorded before from this host. See under *Carcharinus obscurus*, No. 3.
5. *Phoreiobothrium lasium* Linton. Spiral valve. **7**, p. 273. See under *Carcharinus obscurus*, No. 6. July 31, 1899; from one host, 4.
6. *Platybothrium parvum* sp. nov. Spiral valve. **7**, pp. 273 and 300, pl. XLII, figs. 98, 99. July 31, 1899; from one host, 2. See under *Carcharinus milberti*, No. 6.
7. *Otobothrium crenacolle* Linton. Spiral valve. **2**, pp. 850–853, pl. XIII, figs. 9–15, and pl. XIV, figs. 1–4. **7**, p. 273.
8. *Tetrarhynchus.* Encysted in intestinal wall. **4**, p. 808.
9. *Tænia* sp. [Pl. XXV, figs. 274–281; pl. XXVI, fig. 282.]

July 31, 1899; several attached to mucous membrane of intestine. About a dozen were attached firmly, their heads embedded in the intestinal wall within a space about 10 mm. square. Specimens not measured when first taken. The alcoholic specimens are not in good condition, being rather fragile. Dimensions of two specimens, in millimeters: Length, 14 and 24; diameter of head, 0.86 and 0.70; diameter of neck, 0.60 and 0.50; length of last segment, 0.50 and 0.70; breadth of last segment, 2 and 2.40; diameter of suckers, 0.34 and 0.22. Length of a free segment, 8.5; breadth, 2.5. Some of the ova nearly circular in outline, with the diameter 0.17; others ovate with maximum diameter as much as 0.22; one 0.17 and 0.21 in the two principal diameters. Cirrus long, armed with hooks; length of hooks, 0.014. This species suggests *Tænia gibbosa* Leidy, from a species of *Lamna* inhabiting the Pacific coast of North America.

Alopias vulpes, *Thrasher*.

The viscera of one specimen were examined July 6, 1887, but no entozoa were found. Another, examined August 20, 1900, had remains of small fish in the intestine. No entozoa found.

Carcharias littoralis (*Odontaspis littoralis*), *Sand Shark*.

FOOD.

Fish (menhaden, sea bass, scup, and butter-fish noted) and squid.

ACANTHOCEPHALA.

1. *Echinorhynchus carchariæ*. **3**, pp. 536–537, pls. LIX, LX, figs. 81–84.
2. *Echinorhynchus acus* Rudolphi. Aug. 12, 1899, from one host 1. Spiral valve. Probably introduced with food. **7**, p. 273.

NEMATODES.

3. *Acanthocheilus* sp. Stomach. July 21, 1899, from one host 3; Aug. 9, 1899, from one host 1; Aug. 12, 1899, from one host 1.

These worms are rather plump, thickest in the middle and tapering equally to each end. Length, 34 to 44 mm.; diameter reaching 2 mm. Mouth provided with three minute lips. No males seen.

4. *Ascaris* sp. [Pl. XI, figs. 127–130.]

A few specimens found in the intestine on different occasions, immature, most of them certainly young ascarids. They have evidently been introduced with the food and probably would not develop further in this host. The specimen shown in figs. 127–128 was collected August 2, 1886. Length, 17 mm.; maximum diameter from middle to posterior third of body, 0.57 mm.; body crossed with transverse striæ; wall of intestine tessellated. Figs. 129–130 show an immature female, length, 50 mm.; diameter, middle to posterior fifth, 1.6 mm.

CESTODES.

5. *Crossobothrium laciniatum* Linton. Spiral valve. **1**, pp. 469–474, pl. III, figs. 4–18. **2**, pp. 799–802, pl. VII, fig. 4. **5**, pp. 445–446. **7**, p. 273.

July 17, 1899; 20. July 21, 1899; several. Aug. 9, 1899; numerous. Aug. 12, 1899; 2. Aug. 15, 1899; 1. In this specimen the stomach was empty, the intestine contained a viscid mucus and there was a diseased patch of mucous membrane at pyloric end of stomach, the surface being caked and hard. Aug. 17, 1899; 4. Aug. 18, 1899; 55, large and small. Aug. 19, 1899; 12. July 20, 1900; 47 from one and 16 from another, young and adult. Two small worms in this lot present some points of difference from the young of this species with which they were associated. Bothria provided with an auxiliary acetabulum as in *Crossobothrium* but smaller, more slender, and less mobile; body slender, with apparently true proglottides, which were elongated and without any indication of laciniæ. Habit of worm like that of form heretofore called by me *Orygmatobothrium angustum*. Aug. 12, 1900; numerous. Aug. 13, 1900; 106, young and adult, with numerous free, ripe proglottides.

Dr. Dahlgren reports that many sand sharks have been opened this season (July–August, 1900) to supply material for work on cestodes in the Marine Biological Laboratory, and that this species has been found in great abundance in all of them. This species may be identical with *Tetrabothrium barbatum* Leidy. Fig. 235 is a sketch of the posterior end of a young strobile which appeared to be dividing into four by the abnormal enlargement of the laciniæ.

6. *Rhynchobothrium longicorne* Linton. Spiral valve. **2**, pp. 847–849, pl. III, figs. 4–8. **5**, p. 450. Aug. 9, 1899; 4.

7. *Rhynchobothrium*. Encysted in walls of stomach and intestine. **4**, p. 798. Aug. 18, 1899; blastocyst from cyst in stomach wall.

Isurus dekayi, *Mackerel Shark*.

FOOD.

One specimen, taken by the schooner *Grampus*, July 30, 1900, had a conger eel and fragments of fish in the stomach. Entozoa collected by Mr. C. W. Stone, in formalin when examined.

NEMATODES.

1. *Immature nematodes*. Intestine.

Few, small; length of largest, 12 mm. Same type frequently found in a great variety of fish. A diverticulum from base of proboscis and another from anterior end of intestine.

CESTODES.

2. *Anthobothrium laciniatum* Linton. Spiral valve. Not recorded before from this host. See under *Carcharinus obscurus*, No. 3.

These individuals, 5 in number, are smaller than specimens from the dusky shark. Dimensions in millimeters: Length, 5; breadth of head, 0.61; length of head, 0.34; diameter of neck, 0.09; distance of first segment from head, 0.36; last segment, length 0.58, breadth 0.43.

3. *Monorygma* sp. Spiral valve. Twelve specimens, all very small and identical with No. 4, under *Carcharinus milberti*.

The heads of the living worms were not seen, and it is difficult to determine the exact nature of the contracted specimens. There appears to be a myzorhynchus and the character of the acetabulum seems to be quite different from that of the species I have been erroneously calling *Orygmatobothrium angustum*. The auxiliary acetabulum of the latter resembles that of *Crossobothrium* and of *Phyllobothrium*. In the case of these specimens the auxiliary acetabulum is relatively larger than in the genera just named and appears to be simply the anterior part of the bothrium separated by a transverse partition.

The resemblance of head to that of *Monorygma chlamedoselachi* Lönnberg is very striking. The neck is minutely serrate in outline. The ripe segments are very easily detached. Some free segments which probably belonged to this species were much larger than the dimensions of the last segment given below. Dimensions of one in millimeters: Length, 3.77; length of head, 0.35; breadth of head, 0.42; diameter of neck, 0.15; distance to first segment, 1.6; last segment, length, 0.65; breadth, 0.17. Similar forms found in *Galeocerdo* and *Isurus*.

4. *Thysanocephalum ridiculum* sp. nov. Spiral valve. [Pl. XXVII, figs. 294, 295.]

A few very small specimens with scolices which agree in minute detail with the head proper of *T. crispum*, but without the characteristic pseudoscolex of that species, were found. The head is quadrangular, the bothria oblong, each of the four with two short, conical hooks, which are the lateral prolongations of a transverse partition. The structure of these hooks is entirely different from that of the ordinary chitinous hooks of cestodes and acanthocephala. It appears to be of the same essential nature as the thickened borders of the bothria, but denser. This has already been shown for *T. crispum* (Report of U. S. Fish Commission for 1888, p. 547, pl. LXII, fig. 13). Back of the hooks the bothria are somewhat trough-shaped. In front of the hooks the bothria are prolonged in some, short in others. The contraction states are more variable in the anterior than in the posterior parts of the bothria. The anterior portion evidently has suctorial functions. It has the appearance of a distinct loculus in contraction. The strobiles are short, the proglottides rather irregular, easily detached, posterior ones elliptical, making the chain moniliform in outline. Dimensions in millimeters: Length, 3.36; diameter of head at hooks, 0.72; in another, 0.26; length of bothrium, 0.75; in another, 0.44; breadth of bothrium, 0.50; in another, 0.17; length of hooks, 0.06; diameter of neck 0.25, swelling to 0.46 at 0.29 from head; in another, 0.14, swelling to 0.20 at 0.14 from head.

5. *Platybothrium parvum* sp. nov. Spiral valve.

These specimens, of which 57 were found, are identical with No. 6 under *Carcharinus milberti*. Upon superficial examination one would be disposed to place them in the genus *Phoreiobothrium*. The character of the hooks, however, is unmistakable. The longest specimens measure about 10 mm. They are not in good condition for measuring, being more or less coiled up. The segments drop off very easily. A few retained, six in one case, give to the strobile a characteristic moniliform appearance. In such cases the segments may be a little longer than broad, as long as broad or broader than long. For further details of this species, see under *C. milberti*, No. 6.

6. *Tetrarhynchus robustus* Linton. Scolex, spiral valve. One scolex with beginning of strobile. [Pl. XXI, fig. 242.]

Squalus acanthias, *Horned Dog-fish, Spiny Dog-fish.*

FOOD.

A specimen examined by me July 26, 1900, had been confined in the pool two or three weeks. The alimentary tract was almost entirely empty, except a few bits of eelgrass and the test of a young sea-urchin 1.5 mm. in diameter. Vinal N. Edwards says he has examined the stomachs of this dog-fish and found them filled with ctenophores. No entozoa were found. Mr. C. F. Silvester reports that he finds fish of various kinds in the stomachs of spiny dog-fish from Provincetown, Mass.

7, p. 274.

Raja erinacea, *Summer Skate.*

FOOD.

Usually crustacea and annelids, but bivalve mollusks, squid, and fish also frequently found in the stomach. In the summer of 1899 thirty-two skates were examined and the following food material noted: Crabs (hermit, *Cancer*, *Callinectes*, *Panopeus*, and others), shrimps, amphipods, annelids, squid, bivalve mollusks, small fish.

NEMATODES.

1. *Ascaris rotundata* Rudolphi. Stomach and intestine. [Pl. III, figs. 14–18.]

Nematodes found on several occasions are referred to this species. Length of males, 12 to 18 mm.; females, 25 to 40 mm. There are three postanal, one large and two small, and eight or nine preanal papillæ on each side in the male. Mouth trilobed, the lips projecting into blunt papillæ, and

surrounded by a circle of minute teeth, which traverses the middle of inner surfaces of lobes, there being twelve or more of these dentigerous ridges on each lip.

2. *Nematodes*, immature.
   Found on a few occasions in the alimentary tract, evidently introduced with food.

CESTODES.

3. *Echeneibothrium variabile* Beneden. Spiral valve. **1**, pp. 460–462, pl. I, figs. 9–13. **2**, pp. 766–767. **5**, p. 440. **7**, p. 274. In 1899, 4 found, 32 skates examined. July 9, 1900, 24 skates examined, no *E. variabile*.
4. *Rhynchobothrium imparispine* Linton. Spiral valve. **2**, pp. 840–843, pl. XII, figs. 6–9. **5**, p. 450. July 27, 1899; blastocyst, with larva, in stomach. Aug. 4, 1899; larva, in stomach. Food in two latter cases consisted of annelids, bivalve mollusks, *Cancer irroratus*, and shrimp. July 9, 1900; one specimen obtained from a lot of 24 skates; length in alcohol, 56 mm.
5. *Rhynchobothrium tumidulum* Linton. Spiral valve. Aug. 12, 1899; 1. First record of this species in the skate. See under *Mustelus canis*, No. 7.
6. *Tetrarhynchus*, cysts. Intestinal wall. **4**, p. 809. July 19, 1899; two small cysts, with degenerate connective tissue in stomach wall. Aug. 17, 1899; several cysts in intestinal wall, filled with degenerate tissue which effervesces briskly with dilute hydrochloric acid.

Raja ocellata, *Big Skate, Winter Skate.*

FOOD.

Squid and annelids.

NEMATODES.

1. *Nematode*, immature. **7**, p. 274.

CESTODES.

2. *Rhynchobothrium imparispine* Linton. **7**, p. 274. See under *Raja erinacea*, No. 4.
3. *Cyst.* Stomach wall. **7**, p. 274.

Raja eglanteria, *Brier Ray.*

NEMATODES.

1. *Ascaris rotundata* Rudolphi. One male specimen in U. S. N. M. collection; length, 12 mm. Four small postanal and eight larger preanal papillæ were counted on each side. See under *Raja erinacea*, No. 1.

Raja lævis, *Barndoor Skate.*

FOOD.

Two specimens taken by the schooner *Grampus* off Gay Head July 30, 1900, in 65 to 70 fathoms, and examined by Mr. C. W. Stone, were found to have lobsters in their stomachs.

CESTODES.

1. *Rhinebothrium minimum* Beneden. Spiral valve. **5**, pp. 441–442, pl. XXXIII, fig. 5.
2. *Acanthobothrium coronatum* Rudolphi. [Pl. XXVI, fig. 293.] Spiral valve. July 30, 1900, 16; the longest measured 90 mm. in formalin; several had their heads firmly embedded in intestinal wall, in which places some of the surrounding tissue seems to have undergone some degeneration. Dimensions of a specimen in glycerine, slightly compressed, in millimeters: Length, 58; length of head, 1; breadth of head, 1; breadth of neck, 0.4; length of hooks, 0.17; length of first distinct segments, 0.03; breadth, 0.45; length of last segment 1, breadth 0.57; length of a free segment 2.7, breadth 0.9.
3. *Rhynchobothrium imparispine* Linton. Spiral valve. July 30, 1900; 1. First record of this species in this host. See under *Raja erinacea*, No. 4.
4. *Tetrarhynchus robustus* Linton. July 30, 1900; 3 scolices, which look as if they had but recently emerged from their cysts. See under *Dasyatis centrura*, No. 18.

TREMATODES.

5. *Distomum veliporum* Creplin. Stomach. **6**, pp. 521–522.
6. *Distomum* sp. [Pl. XXXI, figs. 348, 349.]

A single specimen collected July 30, 1900, was at first thought to be near *D. fœcundum.* The general habit of the body is much as in that species. The opening of the acetabulum, however, instead of being transverse, is longitudinal. It suggests also Beneden's *D. cestoides,* but the testes appear to lie transversely near the posterior end instead of on the median line. As far as can be made out from an examination of the specimen in glycerine, it has the following characters: Body smooth, thickish, depressed, of nearly the same breadth throughout, rounded at each extremity; aperture of mouth nearly circular, a little wider than long; acetabulum much larger than oral sucker, aperture elongated; pharynx pyriform, with the larger end in front and overlapped by the oral sucker; œsophagus at least as long as pharynx; intestinal rami not clearly made out, but apparently simple and reaching to the posterior end; cirrus passes dorsal to the acetabulum to the right of the œsophagus as far as the pharynx, whence it curves back and opens at the anterior border of the acetabulum. Testes two, side by side near the posterior end; ovary smaller, apparently two-lobed, in front of testes and toward the left; uterus in front of testes in middle of body; ova of different sizes. Vitellaria two narrow clusters of small dark-brown bodies lateral to the testes, the one on the right extending less than halfway to the acetabulum, the other a little more than halfway. Dimensions in millimeters: Length, 7.5; breadth, 2; oral sucker, length 0.97, breadth 0.94, aperture 0.25 long and 0.28 wide; acetabulum, length 1.38, breadth 1.5, aperture 0.48 long and 0.33 wide; pharynx, length 0.44, greatest breadth 0.33; larger ova 0.086 and 0.045, smaller 0.062 and 0.035, in the two principal diameters.

Tetronarce occidentalis, *Torpedo.*

FOOD.

The alimentary canal was nearly empty in all the torpedoes I have examined, a few remains of fish being about the only identifiable contents. The stomach and intestine in all cases, including one specimen examined in 1889 and two in 1900, contained an extremely viscid and tenacious mucus. The extraordinary thickness of the walls of the alimentary tract is apparently associated with equally extraordinary digestive power.

CESTODES.

1. *Calyptrobothrium occidentale* Linton. Spiral valve. **7,** pp. 274–275 and 298–299, pl. XLI, figs. 92–97. July 29, 1899; 3 strobiles; scolices not found. July 16, 1900; 5, small, 20 to 27 mm. in length, only 1 with scolex. The changes wrought in the appearance of the scolex of this species by different states of contraction are very diverse.
2. *Rhynchobothrium imparispine* Linton. Larvæ in cysts in intestinal wall. **7,** p. 275.
3. *Tetrarhynchus bisulcatus* Linton. **5,** pp. 810–811, pl. LXVI, figs. 13, 14.

Dasyatis centrura (*Trygon centrura*), *Sting Ray.*

FOOD.

The stomachs of the sting rays which I have examined have been, as a rule, empty. Fragments of crustacea and annelids, however, have been found in most cases somewhere in the alimentary tract; small fish recorded in one instance.

NEMATODES.

1. *Ascaris* (?). Immature. Spiral valve.

A single specimen collected August 1, 1887. It is immature, has been introduced with food, and the sting ray may not be its proper host. Body smooth, of nearly uniform diameter, with fine longitudinal striæ. Head with four blunt, rather obscure papillæ. Tail slenderly mucronate. Some dimensions in millimeters: Length, 18; diameter of head, 0.08; length of œsophagus 1.12, diameter 2 mm. from head at middle and 2 mm. from posterior end 0.22; diameter at anal aperture, 0.12; distance of anal aperture from posterior end, 0.16. The body enlarges slightly at base of œsophagus.

CESTODES.

All except encysted forms from spiral valve.

2. *Anthobothrium pulvinatum* Linton. [*Rhodobothrium pulvinatum,* Am. Journ. Sci. and Arts, March, 1889.] **2,** pp. 759–765, pl. IV, figs. 4–9; pl. V, figs. 1–2. **5,** pp. 439–440, pl. XXX, fig. 1. **7,** p. 275. Aug. 24, 1899; 1; large, with large number of free proglottides.

3. *Paratænia medusia* Linton. [Pl. XXVI, figs. 290–291.] **2**, pp. 862–866, pl. XV, figs. 5–9. **5**, p. 440. **7**, p. 275. July 19, 1899; very numerous.

Much smaller than specimens found in previous years. Dimensions in millimeters: Length of head and chain of 10 segments, 0.5; length of last segment, 0.2; length of head, 0.08; diameter of head, 0.08. In some the segments were rounded and the chain moniliform; in others the segments were squarish or rectilinear in outline and crowded together; but in all cases they separate easily from each other.

4. *Spongiobothrium variabile* Linton. **1**, pp. 462–464, pl. II, figs. 13–16. **2**, pp. 778–780. **5**, p. 442. **7**, p. 275. July 19, 1899; 13 from upper part of spiral valve.
5. *Rhinebothrium flexile* Linton. **2**, pp. 768–771, pl. V, figs. 3–5. **7**, p. 275.
6. *Rhinebothrium cancellatum* Linton. **7**, p. 275. See under *Rhinoptera bonasus*, No. 1.
7. *Phyllobothrium foliatum* Linton. **2**, pp. 787–794, pl. VI, figs. 5–10. **5**, p. 443. **7**, p. 275. Aug. 24, 1899; 9, and a large number of free proglottides.
8. *Anthocephalum gracile* Linton. **2**, pp. 794–796, pl. VII, figs. 1–2. **7**, p. 275.
9. *Lecanicephalum peltatum* Linton. **2**, pp. 802–805, pl. IX, figs. 2–4. **7**, p. 275. July 19, 1899; 4.
10. *Orygmatobothrium crenulatum* Linton. **5**, pp. 444–445, pl. XXXIII, figs. 9–12, pl. XXXIV, fig. 1.
11. *Acanthobothrium paulum* Linton. **2**, pp. 816–819, pl. VIII, figs. 1–7. **7**, p. 275. July 19, 1899; 25 in lower part of spiral valve.
12. *Onchobothrium uncinatum* Diesing. **5**, p. 446, pl. XXXIV, figs. 2–5.
13. *Rhynchobothrium hispidum* Linton. **2**, pp. 833–835, pl. XI, figs. 12–17. **7**, p. 275. July 19, 1899; very numerous, with many ripe proglottides. The latter become dark colored after lying in water for a few hours. The heads adhere very closely to the mucous membrane and may be overlooked by the inexperienced collector.
14. *Rhynchobothrium longispine* Linton. **2**, pp. 835–837, pl. XI, figs. 18–20.
15. *Rhynchobothrium tenuispine* Linton. **2**, pp. 837–838, pl. XII, figs. 1–2. **5**, pp. 448–449, pl. XXXIV, fig. 8.
16. *Rhynchobothrium wageneri* Linton. **2**, pp. 843–845, pl. XII, figs. 10–12.
17. *Tetrarhynchus tenuis* Linton. **2**, pp. 853–855, pl. XIV, figs. 5, 6. **5**, p. 452.
18. *Tetrarhynchus robustus* Linton. **2**, pp. 855–857, pl. XIV, figs. 7–9.
19. *Tetrarhynchus.* Cysts in the stomach wall. **4**, pp. 808–809. July 19, 1899; cysts under serous coat of stomach and pylorus; also a large one on the spleen. These were all filled with degenerate tissue, yellowish white and of a cheesy consistency.
20. *Synbothrium filicolle* Linton. [*Syndesmobothrium filicolle.*] **2**, pp. 861–862, pl. XV, figs. 2–4. **4**, p. 819, pl. LXVIII, fig. 10. **7**, p. 275.

TREMATODES.

21. *Epibdella bumpusii* Linton. External. **7**, pp. 275, 286–287, pl. XXXIV, figs. 11–15.

Mr. Vinal N. Edwards says that this ectoparasite is usually found on the sharp-nosed ray.

22. *Branchiobdella rarenelii* Diesing. External. Found on several occasions. Report of U. S. Fish Commission for 1871–72, p. 624, pl. XVIII, fig. 89.

PROTOZOA.

23. In the intestinal contents of a sting ray examined July 19, 1899, enormous numbers of small bodies were seen, long-elliptical in outline and measuring 0.014 mm. and 0.006 mm. in the two principal diameters [pl. I, fig. 5].

Myliobatis freminvillei, *Sharp-headed Ray.*

FOOD.

The stomachs of the few specimens which I have examined have been empty, with the exception of one, in which were pieces of a large univalve mollusk, probably *Sycotypus.*

CESTODES.

All cestodes from spiral valve.

1. *Rhinebothrium longicolle* Linton. **2**, pp. 775–778, pl. VI, figs. 1–4. **5**, pp. 441, pl. XXXIII, figs. 2–4. **7**, p. 275.

2. *Echeneibothrium* sp. [Pl. XXVI, figs. 285–288.] From a specimen taken by the schooner *Grampus* July 29, 1899, off Gay Head in 65 fathoms. Specimens collected by Mr. J. A. Stewartson.

Specimens small, not exceeding 10 mm. Length of head of one which measured 7.5 mm. was 0.38 and the breadth 0.43 mm. The bothria were contracted by the formalin, in which they had been placed, and their real structure is difficult to make out. Upon superficial view they appear to be divided into five loculi, by transverse costæ. A single bothrium was separated and placed in acetic acid, and showed a structure much like that found in *R. minimum* (**5**, pp. 441–442, pl. XXXIII, fig. 5); that is, nine or ten loculi arranged around a central space. In one specimen the bothria were distinctly in pairs, which corresponded to the flat surface of the body. In their contracted condition the bothria are attached by their posterior ends and project forward; their borders are finely crenulate; slightly tumid immediately behind the head, but evidently capable of elongation, and may appear very different under varying conditions; transversely striate, striæ merging quickly into divisions between segments. Strobiles clavate, posterior edges of segments slightly projecting. Mature segments not seen. A cylindrical myzorhynchus with a terminal aperture was seen in one specimen, projecting a little in front of the anterior edges of the bothria.

3. *Acanthobothrium paulum* Linton. July 29, 1899; 1. See under *Dasyatis centrura*, No. 11.
4. *Rhynchobothrium agile* Linton. **5**, p. 451, pl. XXXIV, figs. 12–15. **7**, p. 275.
5. *Rhynchobothrium imparispine* Linton. July 29, 1899; numerous. The specimens in this lot are variable, but the character of the hooks is that of this species. The size is smaller than those upon which the species was founded. See under *Raja erinacea*, No. 4.
6. *Tetrarhynchus robustus* Linton. **7**, p. 276. See under *Dasyatis centrura*, No. 18.
7. *Rhynchobothrium*. Cysts. July 29, 1899; from stomach wall between mucosa and submucosa, about 2 mm. in length. The hooks seen through sheath suggest *R. longispine* (**2**, pp. 835–837, pl. XI, figs. 18–20).

TREMATODES.

8. *Distomum macrocotyle* Diesing. July 29, 1899; 3 and fragment from stomach. The two largest specimens measure 16.5 mm. in length and 2 mm. and 3.4 mm., respectively, in breadth.

Chimæra affinis.

NEMATODES.

1. *Ascaris rotundata* Rudolphi.

One male, length 22 mm.; fragment of female, length 34 mm.; maximum diameter about middle, 1.5 mm.; collected by S. E. Meek, Fulton Market, New York, October, 1886.

Rhinoptera bonasus (*Rhinoptera quadriloba*), *Cow-nosed Ray.*

FOOD.

The following material has been noted: Adductor muscles of clam, opercula of some gasteropod mollusk (*Lunatia?*) packed together like a pile of saucers, a small lobster, fragments of crabs, and other crustacea.

CESTODES.

All from spiral valve.

1. *Rhinebothrium cancellatum* Linton. **2**, pp. 771–775, pl. V, figs. 3–5.
2. *Echeneibothrium* sp. [Pl. XXVI, figs. 283, 284.] Near *E. affine* Olsson. 1899, Aug.; 3 small specimens; from ray taken by the steamer *Fish Hawk*.

These worms do not exceed 10 mm. in length. They differ from No. 2 under *Myliobatis freminvillei* in the more pedicellate character of bothria and less definite loculi on same. The myzorhynchus, instead of being cylindrical, is conical when extended; when retracted the head looks like *E. variabile*, only much smaller. Dimensions of a specimen in millimeters: Length, 7.5; length of bothrium, 0.30; breadth of head, 0.50; breadth of bothrium, 0.17; diameter of myzorhynchus, at base 0.07, at apex 0.04; diameter of body just behind head, 0.09; last segment (irregular length), 0.73; greatest breadth, anterior, 0.23; least breadth, posterior, 0.12; penultimate segment, length 0.38, breadth 0.29.

3. *Tylocephalum pingue* Linton. **2**, pp. 806–809, pl. IX, figs. 5–9.
4. *Rhynchobothrium brevispine* Linton. **5**, pp. 450–451, pl. XXXIV, figs. 9–11.
5. *Rhynchobothrium agile* Linton. **5**, p. 451, pl. XXXIV, figs. 12–15.
6. *Tetrarhynchus robustus* Linton. **5**, p. 452. See also under *Dasyatis centrura*, No. 18.

Acipenser sturio, *Sturgeon.*

NEMATODES.

1. ***Dacinitis sphærocephala*** Dujardin. [Pl. XVI, figs. 200–202.] Aug. 5, 1884; 1, a female with embryos from intestine. Dimensions in millimeters: Length, 24; diameter of head, 0.38; length of œsophagus, 2.1; greatest diameter, 5 mm. from head, 0.64; diameter 4 mm. from posterior end, 0.5; diameter at anal aperture, 0.24; distance of anal aperture from posterior end, 0.5.

CESTODES.

2. Cysts on spleen, coat of stomach, and intestine.

TREMATODES.

3. *Nitzschia elongata* Nitzsch. [*Nitzschia elegans* Baer.] Gills. **6**, p. 508.

Acipenser brevirostris, *Short-nosed Sturgeon.*

ACANTHOCEPHALA.

1. *Echinorhynchus attenuatus* Linton. **3**, p. 529, pl. LV, figs. 23–30.

Acipenser rubicundus, *Lake Sturgeon.*

The following notes on entozoa from the lake sturgeon are given in this connection.

ACANTHOCEPHALA.

1. *Echinorhynchus globulosus* Rudolphi.

Two specimens in the U. S. National Museum collection, collected by J. W. Milner, appear to belong to this species.

TREMATODES.

2. *Distomum auriculatum* Wedl. **6**, pp. 521–522, pl. LXV, figs. 8–10, pl. LXVI, figs. 1–5.

Pratt proposes the name *Bunodera lintoni* for this species.

Anguilla chrysypa (*Anguilla vulgaris*), *Eel.*

FOOD.

Shrimp, crabs, annelids, mollusks, small fish.

ACANTHOCEPHALA.

1. *Echinorhynchus globulosus* Rudolphi.

Three specimens in the U. S. National Museum collection appear to belong to this species. Male, 5.5 mm.; female, 6 mm. Aug. 7 and 28, 1899; numerous. Male, 7 mm.; female, 10 mm. This species resembles *E. acus*, but differs from that species in the greater relative length of the lemnisci, the erect and usually distinctly tapering proboscis, and the tubular instead of globular prostate gland.

2. *Echinorhynchus agilis* Rudolphi.

Two specimens from the U. S. National Museum collection. **1**, pp. 490–492, pl. V, figs. 1–6.

NEMATODES.

3. *Immature nematodes* (*Ascaris* sp.). [Pl. XI, figs. 125, 126.] **7**, p. 276. Aug. 5, 1899; 2 immature, encapsuled on viscera.

Two specimens in the U. S. National Museum collection; also immature and encapsuled. Length, 22 mm.; diameter, 1 mm. Somewhat attenuate anteriorly, tail pointed and mucronate at tip (*Agamonema capsularia*).

CESTODES.

4. *Tænia dilatata* Linton. **1**, pp. 488–489, pl. V, figs. 14–16. **5**, p. 425.

Specimens of this genus also taken in 1899; three on August 2. Dimensions in millimeters: Length, 8; diameter of head, 0.28; diameter of sucker, 0.08. Segments not mature. One specimen August 28; length, 14 mm. [Pl. XXV, figs. 272, 273.]

5. *Rhynchobothrium heterospine* Linton. **1**, p. 799, pl. LXIV, figs. 3–8. See under *Mustelus canis*, No. 8.
6. *Rhynchobothrium imparispine* Linton. **7**, p. 276. See under *Raja erinacea*, No. 4.
7. *Rhynchobothrium bulbifer* Linton. Aug. 12, 1899; numerous cysts on viscera.
8. *Rhynchobothrium*. Cysts. **4**, p. 794, pl. LXII, fig. 16, and pl. LXIII, fig. 1. **7**, p. 276.
9. *Larval cestodes* (*Scolex polymorphus* Dujardin). **7**, p. 276. Seen also Aug. 12, 1899.

TREMATODES.

10. *Distomum grandiporum* Rudolphi. **6**, pp. 520–521, pl. XLIV, fig. 9. Aug. 28, 1899; 1. Length, 10 mm. See under *Pseudopleuronectes americanus*, No. 6.
11. *Distomum vitellosum* Linton. Aug. 12, 1899; 1. See under *Merluccius bilinearis*, No. 9.
12. *Distomum* sp. [See pl. XXV, figs. 228, 229.] Aug. 10, 1900.

Resembles species figured in **7**, pl. XXXIV, fig. 72. Dimensions in millimeters: Length, 1.96; breadth, 0.58; diameter of oral sucker 0.19, of acetabulum 0.19; length of pyriform pharynx, 0.17, greatest breadth 0.1; ovum 0.076 and 0.038 in the two principal diameters. Cirrus and uterus pass to right of acetabulum. Specimen not in good condition; probably introduced with food.

Leptocephalus conger, *Conger Eel.*

FOOD.

Fish. Aug. 2, 1899; 1; fish in stomach. July 30, 1900; 1; fish in the alimentary canal. July 31, 1900; 1; a herring and 3 butter-fish in stomach; crystalline lenses and other fragments of fish in intestine. August 25, 1900; 1; young eel and fish in stomach; fin rays and an annelid (*Nereis*) in intestine.

ACANTHOCEPHALA.

1. *Echinorhynchus acus* Rudolphi. July 31, 1900; 7; stout-bodied, yellowish; flaccid when first removed from intestine, became plump after lying in sea water. Aug. 25, 1900; 1; length, 20 mm. For account of species, see **1**, p. 492, and **3**, p. 525.

NEMATODES.

2. *Dacnitis hians* Dujardin. [Pl. XVI, figs. 203, 204.] July 30, 1900; 1; from eel taken by schooner *Grampus* off Gay Head in 65 to 70 fathoms; collected by C. W. Stone.

This specimen agrees with Dujardin's description, but is smaller in some of its dimensions. It probably came from the intestine, since it is an adult female with ova in the uterus undergoing segmentation. Dimensions in millimeters: Length, 20; diameter of head, 0.26; of body at middle, 0.41; length of œsophagus, 1.23; distance of anal aperture from posterior end, 0.65; ova, 0.08 and 0.05 in the two principal diameters; of nearly uniform diameter throughout. A few found August 25, 1900.

3. *Immature nematodes*. Encapsuled on intestine. Several. Same host as No. 2.

CESTODES.

4. *Rhynchobothrium imparispine* Linton. Several larvæ in pyriform blastocysts and cysts on serous coat of intestine. Same host as No. 2. For description of species, see **2**, p. 840.
5. *Larval cestodes* (*Scolex polymorphus* Dujardin). Free in intestine. Aug. 2, 1899; July 31, 1900. For account of similar forms see **5**, p. 789.

TREMATODES.

6. *Distomum simplex* Rudolphi. Aug. 2, 1899; 2. For description of species, see **6**, 525.

Dimensions of specimens in water, given in millimeters: Length, 4; diameter, anterior 0.21, at middle 0.61, posterior 0.21; length of oral sucker 0.21, depth 0.19; length of acetabulum 0.37, depth 0.36; ovum, 0.073 and 0.045 in the two principal diameters; length of second specimen, 2.07. See under *Microgadus*, No. 6.

7. *Distomum vitellosum* Linton. Intestine. **7**, p. 290, pl. XXXVII, figs. 38, 39.

Six small specimens which agree best with this species; collected August 25, 1900. The worms were turgid and motionless, although they were examined as soon as collected, at which time they had been put in salt water. Some specimens of this species, collected at the same time as these, but

from the blue-fish, remained active for a long time. It is likely that these had been introduced along with food into the alimentary tract of the conger and were there in an uncongenial place.

Tarpon atlanticus, *Tarpon.*

NEMATODES.

1. *Ichthyonema globiceps* Rudolphi. [Pl. XVIII, figs. 216, 217.] U. S. National Museum collection.

A tangled mass; original number of constituent individuals not made out. The longest piece, when disentangled, measured 385 mm.; aggregate length of pieces, 3 meters; diameter about 1 mm. Uterus filled with ova. In the earlier folds the ova were dark amber color, spherical, 0.014 mm. in diameter; in later folds the ova were light amber color, elliptical, 0.024 mm. to 0.026 mm. in the longer and 0.02 mm. in the shorter diameter.

CESTODES.

2. *Dibothrium laciniatum* Linton. **5**, pp. 435–436, pl. XXX, figs. 7–16, and pl. XXXI, figs. 1–7.

Clupea harengus, *Herring.*

FOOD.

Only young fish have been examined. The young herring is an indiscriminate surface feeder, as the following food notes will show:

July 17, 1899; 3. Stomachs with young squid and shrimp; one filled with nereis-like annelids, about 30 mm. in length.

July 26, 1899; 23. Copepods and megalops of crab in alimentary canal.

July 27, 1899; 4. Alimentary tract with teeth and setæ of annelids.

July 31, 1899; 100. Small; about 30 mm. in length. Copepods and annelids in stomachs.

August 8, 1899; 7. Small crustacea and diatoms.

July 9, 1900; 12. Eighty millimeters in length. Alimentary canals filled with copepods.

NEMATODES.

1. *Ascaris*, immature.

U. S. National Museum collection. These agree with descriptions of *Agamonema capsularia*, but are evidently young ascarids. Length, 25 mm., tapering more anteriorly than posteriorly, with posterior end minutely mucronate. **7**, p. 277. July 27, 1899; a few encysted on viscera. August 12, 1899; 2 small nematodes from viscera.

CESTODES.

2. *Rhynchobothrium imparispine* Linton. July 17, 1899. Encysted in stomach wall. For description of species, see **2**, p. 840.
3. *Rhynchobothrium.* Larvæ encysted on viscera. **7**, p. 277. July 26 and 27, 1899; a few. One of these is sketched in fig. 229 of pl. XX.
4. *Larval cestode* (*Scolex polymorphus* Dujardin). Small. Free in intestines. July 17, 1899; numerous. July 31, 1899; numerous. For account of similar forms, see **5**, pp. 789–792.

TREMATODES.

5. *Distomum appendiculatum* Rudolphi (?). Intestines. July 26, 1899; 9. July 27, 1899; a few. July 31, 1899; 20. Aug. 8, 1899; several. Aug. 12, 1899; 12. July 9, 1900; 2. For an account of this species, see **7**, p. 289, pl. XXXVI, figs. 25, 26.
6. *Distomum vitellosum* Linton. See **7**, p. 290, pl. XXXVII, figs. 38, 39. July 31, 1899; 1.

I record under this name a small cylindrical distome seen in small number but in various hosts in the summers of 1899 and 1900. The measurements on this specimen from the herring agree with those of *D. vitellosum*. There is an evident œsophagus, which was not made out in the specimens taken in the summer of 1898.

7. *Distomum bothryophoron* Olsson (?). July 26, 1899; 3. July 31, 1899; few.

This species found in the herring and alewife in the summer of 1899. The body is short, fusiform, diameter greatest at acetabulum, about four-tenths of length of body. A few dimensions of one from the herring, in glycerine, given in millimeters are: Length, 0.87; length of oral sucker, 0.12, depth 0.13; length of pharynx, 0.065, depth 0.08; length of acetabulum 0.32, depth 0.15; ova, 0.02 and 0.013 in the two principal diameters. The specimen was lying on its side and was considerably flattened under the compressor. Further description of this species under *Pomolobus pseudoharengus.*

PROTOZOA.

8. *Sporozoa.* [Pl. I, figs. 1–3.] July 26 and 27, 1899.

About half the fish examined on these dates were found by Mr. J. A. Stewartson to be infested with a parasite among the muscles of the back and side. These were not examined closely at the time of collection, but pieces of muscle with cysts were preserved and subsequently sectioned. They were then seen to be sporocysts. On July 9, 1900, a young herring 8 cm. in length was examined. The flesh along the back and sides, from head to tail, was filled with small white tumors. While these were of various sizes, none were large. Two of the larger cysts measured 1.74 by 1.16 and 1.16 by 0.58 mm. in the two principal diameters. The sporozoa when placed so that the four polar vesicles are uppermost are squarish in outline with rounded corners, and measure about 0.007 mm. in diameter (fig. 3). The polar vesicles are of a faint greenish tint, the remainder of the spore colorless.

Sections of the infested muscular tissue show that the spores lie in clusters, which are in some cases enveloped in a definite connective cyst and in others not. The spores were also seen in great numbers lying along the intermuscular connective tissue fascia. One instance was noted in a series of cross sections where a cluster of spores had established themselves in the midst of a muscle fiber (fig. 2). I am informed by Mr. E. E. Tyzzer, who is studying this and other myxosporidia, that he has not found the herring infested with this form, but that about half the young alewives examined are infested; further, that the sporocysts are not common in the larger fish, and, moreover, the spores are not in such good condition. The vitality of the infested fish must necessarily be much impaired by the presence of sporozoa in such great abundance in the tissues, whereby they fall victims to their enemies in larger proportional numbers than do their healthy associates. It is for this reason, doubtless, that there is a less proportional number of infested individuals among the larger fish than among the smaller.

Clupanodon pseudohispanicus, *Spanish Sardine.*

FOOD.

Two small specimens were examined August 15, 1899. The alimentary tract contained numerous copepods.

TREMATODES.

1. *Distomum appendiculatum* Rudolphi. Few. Dimensions of one in glycerine, in millimeters: Length, 0.86; diameter of oral sucker 0.06, of ventral sucker 0.12.

Pomolobus mediocris, *Hickory Shad.*

FOOD.

July 28, 1899; 1; stomach empty. August 13, 1900; 1; fish scale and pen of squid in pylorus. August 16, 1900; 1; fragments of crustacea and a small crab in alimentary tract.

NEMATODES.

1. *Ascaris* sp. [Pl. V, figs. 41–45.]

Twenty-eight large and 3 small specimens from stomach, July 28, 1899. Length of a male 30 mm., of a female 44 mm.; length of smaller specimens, 10 mm. Four postanal papillæ and 28 preanal on each side in male; of the preanal the 10 posterior are the smaller, the remaining 18 larger and in sets of 2; both kinds are in a single row. These specimens have many points of resemblance to *A. clavata.*

CESTODES.

2. *Larval cestodes* (*Scolex polymorphus* Dujardin). Free in intestine, July 28, 1899, and Aug. 13, 1900. For account of similar forms, see **4**, pp. 789–792.

TREMATODES.

3. *Distomum appendiculatum* Rudolphi. Stomach and pylorus. See **7**, p. 289, pl. XXXVI, figs. 25, 26. July 28, 1899; 33. Aug. 13, 1900; numerous. Aug. 16, 1900; numerous.

Dimensions in millimeters, life: Length, 2; diameter of oral sucker, 0.09; diameter of acetabulum, 0.18; ova, 0.024 and 0.012 in the two principal diameters.

Many spherical bodies with concentric structure were noted in the contents of the excretory vessels. The largest of these measured 0.016 mm. in diameter (**7**, p. 288).

While watching a living specimen a curious phenomenon was observed in the vicinity of the shell gland. A fine hair-like body which lay in several coils appeared to be turning rather rapidly around a central space. A somewhat similar appearance was present in two smaller spaces nearby. The specimen, while still living, had been partly stiffened by holding the compressor over the flame of an alcohol lamp for a few seconds. This phenomenon evidently has something to do with the formation of the eggshell, but just what I could not make out.

Pomolobus pseudoharengus, *Alewife*.

FOOD.

Only young have been examined. Thirty-six were examined in July and August, 1899, on five different occasions. In all of them the alimentary canal contained copepods, sometimes in enormous numbers. In the summer of 1900 (July 9 and August 10) fourteen specimens were examined, and in addition to copepods young squid and large numbers of small shrimp were found. These specimens were taken at Wareham and were larger than the fish examined the year before. About the same entozoa are found in the young alewife as in the young herring, with which they are associated.

NEMATODES.

1. *Nematodes*, immature. A few found in one lot in 1899 (Aug. 15).

CESTODES.

2. *Larval cestodes* (*Scolex polymorphus* Dujardin). Free in intestine. Aug. 3, 1899. For account of similar forms, see **4**, 789–792.

TREMATODES.

Obtained by washing out the alimentary canal and decanting the material.

3. *Distomum appendiculatum* Rudolphi. Found on all occasions in 1899, usually numerous. Aug. 10, 1900; very numerous. See **7**, p. 289, pl. XXXVI, figs. 25, 26. Measurements of living specimens in one lot, 1.28 mm. to 2.56 mm.
4. *Distomum vitellosum* Linton. See **7**, p. 290, pl. XXXVII, figs. 38, 39; also under *Clupea harengus*, No. 6.
5. *Distomum bothryophoron* Olsson (?). [Pl. XXXII, figs. 355, 356.] See under *Clupea harengus*, No. 7. Aug. 2, 3, and 19, 1899; very few.

Body smooth, short, fusiform; neck conical; tail tapers to a point. Oral sucker nearly circular in ventral view, aperture broadly triangular; pharynx subglobular, close to oral sucker; œsophagus, none; rami of intestines simple, extending nearly to posterior end. Acetabulum in middle of body, prominent, about twice the diameter of the oral sucker, aperture transverse. Testes two, rather small, oval-elliptical, immediately behind the acetabulum. Ovary behind testes. Exact position not clearly determined. Vitellaria a single six or seven lobed mass, lying laterally toward the posterior end. Ova small, elliptical, very numerous, filling all of body back of acetabulum. Reproductive aperture in front of acetabulum, on median line. Dimensions in millimeters of specimen in glycerine: Length, 0.8; diameter of body, anterior 0.1, middle 0.3, posterior 0.03; diameter of oral sucker 0.1, of acetabulum 0.3; testes, 0.07 and 0.05 in two principal diameters; pharynx, length 0.05, depth 0.07; ova, 0.017 and 0.010 in the two principal diameters. These measurements were made from ventral view, except the pharynx, which was measured in lateral view.

6. *Monostomum* sp. [Pl. XXXIV, figs. 377–379.] Aug. 19, 1899; 4. Very small, oval or elliptical.

Dimensions in millimeters: Length, 0.6; diameter, 0.34; diameter of genital acetabulum, 0.07; diameter of oral sucker, 0.07; ova, 0.02 and 0.017 in the two principal diameters. Vitellaria in two masses lying one on either side of genital acetabulum. Uterus very voluminous; body behind acetabulum filled with ova.

PROTOZOA.

7. *Sporozoa*. Aug. 2, 1899; among the muscles of back and side. Of 22 fish 9 were infected.

Mr. E. E. Tyzzer says that about half of the young alewives examined by him in 1900 have these cysts in the flesh, but that they are less common in the larger fish. For fuller account, see under *Clupea harengus*, No. 8.

Alosa sapidissima, *Shad.*

NEMATODES.

1. *Ascaris* sp. [Pl. XII, figs. 138, 139.]

Immature; body slender, jaws prominent, apparently four teeth on upper lip; posterior end terminates in an acute conical point, roughened in most cases with minute spines; length, 12 mm. These specimens, from U. S. National Museum collection, were in a bad state of preservation when examined by me; date of collection and locality not given.

Brevoortia tyrannus, *Menhaden.*

FOOD.

See Peck's valuable contribution, The Sources of Marine Food, Bulletin U. S. Fish Commission for 1895, pages 351–368.

Thirty-two menhaden were examined in July and August, 1899, on eight different occasions. The character of food could be determined only by the use of the microscope, and was invariably vegetable material, especially diatoms. Large numbers of diatoms of many kinds were found in the intestines of some young specimens, 36 mm. in length, on July 28, 1899; also in an adult specimen on August 25, 1899.

CESTODES.

1. Cysts and blastocysts (*Synbothrium*) on viscera. **7**, p. 277.
2. *Larval cestodes* (*Scolex polymorphus* Dujardin). Small. Free in intestine. **7**, p. 277. July 17, 24, 27, and Aug. 3, 1899. For account of similar forms, see **4**, pp. 789–792.

TREMATODES.

3. *Distomum appendiculatum* Rudolphi. **7**, p. 289, pl. XXXVI, figs. 25, 26. Aug. 3, 1899; a few in intestine.
4. *Distomum vitellosum* Linton. See **7**, p. 290, pl. XXXVII, figs. 38, 39. One specimen found July 27, 1899. See under *Clupea harengus*, No. 6.

Stolephorus brownii, *Striped Anchovy.*

FOOD.

Fifty-two anchovies examined on seven occasions in 1899, from July 26 to Aug. 15. Intestines usually filled with copepods, but in a few cases immense numbers of univalve mollusks were found along with copepods.

NEMATODES.

1. *Immature nematode.* July 26, 1899; 1. Aug. 15, 1899; 1.

CESTODES.

2. *Larval cestodes* (*Scolex polymorphus* Dujardin). Small. Free in intestine. July 26, 1899, and Aug. 3, 1899; several. For account of similar forms, see **4**, pp. 789–792.
3. *Rhynchobothrium.* Cyst on viscera. Aug. 15, 1899; 1.

TREMATODES.

4. *Distomum appendiculatum* Rudolphi. July 31, 1899; 12. Aug. 3, 1899; few. **7**, p. 289, pl. XXXVI, figs. 25, 26.
5. *Distomum* sp. [Pl. XXIX, figs. 319, 320.] Aug. 12, 1899. Slender; minutely spinose.

The life dimensions in millimeters are: Length, 1.71; diameter, anterior 0.09, greatest diameter (one-third of length from head) 0.26, at middle 0.21, near posterior end 0.11; diameter of anterior sucker, 0.07; acetabulum, length 0.10, breadth 0.13; ova, 0.021 and 0.011 in the two principal diameters.

A mounted specimen is decidedly fusiform, with greatest diameter near the middle, at the acetabulum. The neck is conical; the anterior sucker somewhat elongated; the pharynx globose, remote from oral sucker, and followed by a slender œsophagus, which is longer than the pharynx. The median and posterior parts of the body are filled with ova. Dimensions of mounted specimen in millimeters: Length, 1.16; oral sucker, length 0.07, thickness 0.045; diameter of acetabulum 0.09; pharynx, length 0.034, thickness 0.041; diameter of body, anterior 0.065 at acetabulum 0.345, near

posterior end 0.069; ova, 0.021 and 0.010 in the two principal diameters. The entire body is covered with spines; those on the neck are sharp-pointed and triangular; on the body they are smaller and more slender; at the posterior end of the body they are minute. The cirrus is armed with comparatively coarse spines; cirrus pouch elongate. Vitellaria in mounted specimens appear to be two subglobular masses of coarsely polygonal granules, lying dorsal and a little posterior to the acetabulum; testes and ovary not distinctly shown in the specimens, but evidently all near the vitellaria.

Salmo salar, *Salmon.*

NEMATODES.

1. *Immature nematodes* (*Ascaris*). [Pl. xi, fig. 131.]

U. S. National Museum collection; Bucksport, Me., Mr. Atkins, collector. Two nematodes, evidently from capsules. Head with three lobes, body narrowing uniformly but slightly to each end; tail with a minute mucronate tip. Dimensions in millimeters: Length, 20; diameter, maximum 0.4, at anal aperture 0.14; distance of anal aperture from posterior end, 0.13; length of the other specimen, 24; diameter, 0.5. Fig. 90, sketched from a specimen from *Mustelus*, would also answer for these forms.

Salvelinus fontinalis, *Brook Trout.*

NEMATODES.

1. *Cucullanus elegans* Zeder.

U. S. National Museum collection; 5 collected by Dr. Robert F. Morris; locality not given. Female—length, 18 mm.; diameter, 0.45 mm. Male—length, 15 mm.; diameter, 0.25 mm. Ova, oblong-elliptical, 0.04 mm. and 0.02 mm. in the two principal diameters. A characteristic feature of these worms was the strongly marked longitudinal striations.

Osmerus mordax, *Smelt.*

NEMATODES.

1. *Ascaris* sp. Immature.

U. S. National Museum collection; 3 collected February 2, 1882; locality not given. Head with three rudimentary lobes; tail minutely mucronate. Dimensions of one of the largest in millimeters: Length, 41; diameter of head 0.3, middle 0.9, at anal aperture 0.23; distance of anal aperture from anterior end, 0.18. Fig. 90, from *Mustelus*, and fig. 131, from *Salmo*, will also answer for these forms.

CESTODES.

2. *Dibothrium ligula* Donnadieu. **5**, p. 438.

Fundulus heteroclitus, *Mummichog.*

FOOD.

The following fish from Waquoit Bay were examined in 1899: August 7; 26. Alimentary canals filled with green mud, consisting of a variety of vegetable débris, enormous numbers of diatoms, and foraminifers in considerable number. August 28; 22. Alimentary canals filled with vegetable material (eelgrass, etc.). A specimen from Katama Bay, August 28, 1900, had shrimp and other small crustaceans in the alimentary tract.

NEMATODES.

1. *Cucullanus* sp. [Pl. xvii, figs. 207, 208.] Aug. 28, 1899; a few small adults from intestine.

Measurements in millimeters: Length of male, 3.6 (alcoholic), female 4.8 (life), latter with ova segmenting in uterus near genital opening. Dimensions of female, life: Length, 4.8; diameter, anterior 0.11, middle 0.17, posterior at anal aperture 0.09; length of œsophagus, 0.56; diameter of œsophagus, anterior 0.11, middle 0.07, near posterior 0.12, narrowing to 0.07; distance from anterior end to nerve ring, 0.21; distance of anal aperture from posterior end, 0.19; ova, 0.075 and 0.048 in the two principal diameters. Reproductive aperture 2 mm. from posterior end.

2. *Immature nematodes* (*Ascaris*). Aug. 7, 1899; few.

CESTODES.

3. *Larval cestodes* (*Scolex polymorphus* Dujardin). Small. Free in intestine. Aug. 28, 1899. For account of similar forms, see **4**, pp. 789–792.

TREMATODES.

4. *Distomum* sp. [Pl. XXXII, fig. 354.] Aug. 7, 1899; 12. Aug. 28, 1899; 4. Intestine.

Body very minutely spinose, white, translucent; acetabulum and oral sucker about same size; outline of body, long oval; neck, short, continuous with body; greatest breadth in region of testes, near posterior end; ecaudate; acetabulum sessile; rami of intestines simple, elongate; œsophagus as long as pharynx; testes, two, in median line behind uterus; seminal vesicle dorsal to ovary and posterior border of acetabulum; ovary between acetabulum and testes, on right side; pharynx, subglobular; genital aperture in front of acetabulum, on median line; vitelline glands lying at posterior end and along sides of body as far as acetabulum; ova, few, relatively large. Dimensions of specimen in formalin, given in millimeters: Length, 2.72; breadth, anterior 0.43, at acetabulum 0.89, middle 1.07, near posterior 0.36; diameter of oral sucker, 0.26; diameter of acetabulum, 0.29; diameter of ovary, 0.21; diameter of testes, 0.33 and 0.39; ova, 0.11 and 0.07 in the two principal diameters.

5. *Distomum tornatum* Rudolphi. Aug. 7, 1899; 2. Length, 8.5 mm.

Body unarmed, appendiculate; acetabulum larger than mouth, latter subterminal; caudal appendix elongate; cirrus minutely papillate. Dimensions in millimeters, from sections: Oral sucker, length 0.22, thickness 0.19; diameter of pharynx, 0.13; diameter of acetabulum, 0.43; ova, 0.14 and 0.007 in the two principal diameters. See **6**, pp. 513–514, pl. XLII, figs. 6–12.

6. *Diplostomum* sp. Globular cysts in liver. Aug. 30, 1899; specimens from Katama. Diameter of cysts in sections, 0.3 mm. [Pl. XXVII, fig. 307.]

Cyprinodon variegatus, *Short Minnow*.

I have no record of entozoa from this species. Wart-like tumors, caused by myxosporidia (*Myxobolus lintoni* Gurley), are occasionally found. A few have been seen by me in different seasons, but no formal record of them has been kept. **7**, p. 277. Linton, U. S. Fish Commission Bulletin for 1889, pp. 99–102, pl. XXXV. Gurley, U. S. F. C. Bulletin for 1891, p. 414. Gurley, U. S. F. C. Report for 1892, p. 238, pl. XXVII.

Tylosurus marinus, *Gar-fish*.

FOOD.

Fish and shrimps.

ACANTHOCEPHALA.

1. *Echinorhynchus agilis* Rudolphi. Aug. 11, 1899; 4. Intestine. For account of this species, see **2**, p. 490, and **3**, p. 534.

CESTODES.

2. *Larval cestodes* (*Scolex polymorphus* Duj.). Small. Free in intestine. Aug. 11, 1899; few. **7**, p. 277.

TREMATODES.

3. *Gasterostomum* sp. [Pl. XXXIV, figs. 367–368.] **7**, pp. 277, 298, pl. XLI, fig. 91. Aug. 7, 1899; 11.

Thirty gars were examined, and this species found in considerable abundance. It was noted that the body was armed with short, rod-like, deciduous spines. Dimensions of living specimen in millimeters: Length, 1.43; diameter, anterior 0.28, median 0.65, posterior 0.25; ova, 0.017 and 0.012 in the two principal diameters.

Tylosurus acus (*Tylosurus caribbæus*), *Hound-fish*.

I have examined but one specimen of this gar—taken in Buzzards Bay, July 27, 1886. Several specimens of a goose barnacle (*Conchoderma vergata*) were attached to the top of head behind the eyes. Where the barnacles were rooted, the skin was off and the skull of the fish exposed.

ACANTHOCEPHALA.

1. *Echinorhynchus pristis* Rudolphi. **3,** pp. 530–531, pl. LVI, figs. 31–38. Var. *tenuicornis*. **3,** pp. 531–532, pl. LVI, figs. 39–41, and pl. LVII, figs. 42–53.

NEMATODES.

2. *Ascaris* sp. Immature. Intestine. An immature female, 17 mm. long. Lateral alæ for about 1 mm. back of head. Postanal region somewhat elongate, fine spines at posterior tip. Longitudinal muscle bundles strikingly prominent in acetic acid. Resembles No. 1 under *Microgadus tomcod*.

CESTODES.

3. *Dibothrium restiforme* Linton. Intestine. **2,** pp. 722–728, pl. I, figs. 1–16.
4. *Rhynchobothrium speciosum* Linton. Larvæ encysted on viscera. **4,** pp. 801–805, pl. LXV, figs. 4, 5.

TREMATODES.

5. *Distomum nitens* Linton. **6,** pp. 534–535, pl. LI, figs. 5, 6, and pl. LII, fig. 1.

Gasterosteus bispinosus, *Two-spined Stickleback*.

TREMATODES.

One small distome was obtained from the intestine of this species July 24, 1900. A sketch was made of it while it was living. Unfortunately the specimen was lost and no further details of its anatomy than are shown in the sketch can be given. [Pl. XXXI, fig. 350.]

Apeltes quadracus, *Four-spined Stickleback*.

FOOD.

In the summer of 1900 I examined a small number of this and also of the nine-spined and two-spined stickleback. Most of them had been in the aquarium some time and the alimentary tracts were empty. Four taken at Wareham, Aug. 2, had their intestines filled with copepods.

Siphostoma fuscum, *Pipe-fish*.

FOOD.

Small crustaceans found in alimentary canal of pipe-fish taken at Wareham, August 2, 1900.

CESTODES.

1. *Rhynchobothrium heterospine* Linton.

A few cysts from a specimen taken in Katama Bay, August 28, 1900, resemble the forms figured in **4,** pl. LXIV, fig. 3. The larvæ when liberated were found to agree with this species in the character of hooks.

Menidia notata, *Silverside*.

FOOD.

August 28, 1899; 26; small crustacea and vegetable material. August 30, 1899; 23; annelids and shrimp. July 17, 1900; 50; setæ, spines, and jaws of annelids (*Nereis*), a few small (young) univalve mollusks, and small crustaceans. July 27, 1900; 6. Enormous numbers of small (young) univalve mollusks (0.3 mm. and less in length), diatoms, and sand; small copepod parasites on gills, very numerous.

NEMATODES.

1. *Immature nematodes*. Aug. 30, 1899; 2. July 17 and 27, 1900; 1 and fragment.

CESTODES.

2. *Rhynchobothrium*. Larvæ encysted on viscera, Aug. 30, 1899.

TREMATODES.

3. *Distomum tornatum* Rudolphi. [Pl. XXVIII, fig. 310.] Aug. 28, 1899; 30. Aug. 30, 1899; 10. July 17, 1900; few. See No. 4, under *Coryphæna hippurus*.

Maximum size: Length, 11 mm.; diameter, 2 mm.

The following dimensions in millimeters are from sections, longitudinal vertical: Diameter oral sucker 0.22, of pharynx 0.16, of acetabulum (maximum) 0.5, of ovary (maximum) 0.46, of testes (maximum) 0.4; ova, 0.017 and 0.012 in the two principal diameters. These worms have a great variety of shape and color. In some the intestine is dark-brown and quite conspicuous; uterus, with eggs, convoluted in middle portion of body, amber yellow; vas deferens slender, thread-like, convoluted, opaque white. As these distomes lay amid the washings from the alimentary canal of the silverside, which contained the claws and bits of the shells of shrimps, annelids, and black and white strips of the peritoneum of their host, they were rather difficult to distinguish from their surroundings.

4. *Distomum* sp. Small, short, fusiform. [Pl. XXXII, figs. 357, 358.] Aug. 28, 1899; 6. Aug. 30, 1899; 2.

Resembling *D. bothryophoron* Olsson, but with more slender neck and distinct œsophagus.

5. *Distomum valde-inflatum* Stossich. In globular cysts, in the liver (July 17, 1900), and in fat masses in the body cavity (Aug. 30, 1899). These have spines around the mouth and smaller spines on neck. See **6**, pp. 527–528, pl. XLVII, figs. 10, 11, and pl. XLVIII, figs. 1, 2.

Mugil cephalus, *Jumping Mullet*.

FOOD.

August 28, 1899; 21, small, 90 mm. to 100 mm. long. July 28, 1900; 12, small. Fish in both cases from Waquoit Bay. Alimentary tracts filled with green mud, which contained large numbers of diatoms, green algæ, an occasional copepod, and much quartz sand, in minute angular grains. No entozoa were found.

Sphyræna borealis, *Barracuda*.

FOOD.

August 8 and 15, 1899; 8, small; remains of young fish in alimentary canal. July 27, 1900; 2, small; intestines filled with immense numbers of young univalves, 0.15 mm. to 0.3 mm. in diameter. Specimens from Katama. No entozoa found.

Scomber scombrus, *Mackerel*.

FOOD.

The only food notes I have are for young fish. August 2, 1899; remains of small fish. August 8 and 12, 1899; small crustaceans. July 9, 1900; small squid and copepods.

NEMATODES.

1. *Ascaris*. [Pl. VIII, figs. 73, 74, and pl. XIV, figs. 181, 182.]

Immature, probably *A. clavata* Rudolphi; collected by Mr. S. E. Meek, Fulton Market, New York, from the stomach of a mackerel, Aug. 30, 1886. Length, 10 mm.; lateral alæ very prominent. Probably young of *A. clavata*, but postanal region more elongate than usual in that species. On May 3 and 8, 1899, I received from Dr. H. M. Smith about 80 specimens of nematodes (*Ascaris* sp.) taken from mackerels from the New Jersey coast—the smallest specimen about 10 mm., the others 15 mm. to 20 mm. in length. One only is adult—a female 40 mm. in length. One male was noted with a curved spiculum, which had a strong, opaque costa and a rather broad, transparent blade. Many of the smaller specimens are of the type described under the names *Agamonema capsularia* and *Ascaris capsularia* [figs. 181, 182]; others are undoubtedly ascarids. All are probably immature ascarids. Other immature nematodes from the peritoneum have been collected from the mackerel, July 24, 1889, and Aug. 12, 1899. Specimens collected by Mr. Meek, Aug. and Nov., 1886, were probably all young ascarids, although the characteristic jaws of that genus have not yet developed. The longest of these measured 28 mm. It agrees closely with Leidy's description of *Agamonema papilligerus* Diesing.

CESTODES.

2. *Larval cestodes* (*Scolex polymorphus* Dujardin). Small. Free in intestine. Aug. 2 and 3, 1899; July 9, 1900; numerous. For account of similar forms, see **4**, pp. 789–792.
3. *Dibothrium* sp. Young and larva. Intestines. July 9, 1900; a young specimen with about a dozen segments, very active; resembles *Dibothrium punctatum* (**2**, p. 731). Also a flask-shaped larva 2 mm. in length when at rest, but capable of stretching to much greater length.
4. *Rhynchobothrium imparispine* Linton. Encysted. **4**, p. 800.
5. *Rhynchobothrium speciosum* Linton. Encysted. **4**, p. 802.
6. *Rhynchobothrium bulbifer* Linton. [Pl. XXI, fig. 244.] Aug. 2, 1899. Encysted in muscles of back.

TREMATODES.

7. *Distomum vitellosum* Linton. See **7**, p. 290, pl. XXXVII, figs. 38, 39. Aug. 2, 1899; July 9, 1900.

A few small distomes which agree with this species in essential characters were seen on the two dates given. These were very active and assumed such a great variety of shapes that they can not be characterized briefly. Within the space of a second or two the length may change from 0.7 mm., for example, to three times that length or more. The vitellaria are opaque dead-white, other portions translucent bluish-white. Ova, few, rather large, dimensions the same as those given for *D. vitellosum*. In death the worms are cylindrical, acetabulum prominent, neck sometimes reflexed. This remark applies to those distomes which in this paper are referred to this species. The characteristic subangular appearance of the vitellaria is not evident in the living specimens.

8. *Distomum appendiculatum* Rudolphi. Aug. 2, 1899; few. Aug. 12, 1899; 30. **7**, p. 289, pl. XXXVI, figs. 25, 26.

These appendiculate distomes agree exactly with those from the flounder, which were referred with much hesitation to *D. appendiculatum*.

Gymnosarda pelamys, *Ocean Bonito*.

1. *Tristomum læve* Verrill. Gills. **6**, p. 509, pl. XL, figs. 7, 8.

Thunnus thynnus, *Horse Mackerel*.

FOOD.

I had no opportunity to examine this fish for parasites until the summer of 1900. On July 16 the head (weight, 184 pounds) and viscera of a specimen, taken in a fish trap at Menemsha Bight, on the 14th were brought to Woods Hole. The only indication of the character of the food was the jaw of a squid in the intestine. The only entozoa were two distomes in the stomach.

TREMATODES.

1. *Distomum clavatum* Rudolphi.

Larger specimen 17 mm. long and 7 mm. in greatest diameter. The smaller was 15 mm. and 5 mm. in the corresponding dimensions. See **6**, pp. 539–540, pl. LIII, figs. 8–11.

Sarda sarda, *Bonito*.

FOOD.

The stomachs of bonitos which I have examined have usually been empty, but occasionally I have found fragments of fish and squid in the alimentary canal. See also **7**, pp. 277–278.

NEMATODES.

1. *Ascaris* sp. [Pl. V, figs. 37–40.]

Eight in stomach of one fish July 15, 1899. Length of male, 25 mm.; of female, 40 mm. Anal papillæ much as in *A. habena*. On each side there are 5 small postanal papillæ and 10 small preceded by at least 20 larger preanal papillæ. The jaws are prominent and two-toothed. The cuticle was imperfect in most of the specimens, as if it had been attacked by the digestive fluids.

2. *Immature nematodes* (*Ascaris*).

U. S. National Museum collection; U. S. Fish Commission, 1883. The label reads: "Side of bonito, external." Length, 12 mm.; diameter, 0.26 mm. Posterior end acute, but truncate at tip.

3. *Ichthyonema* sp. July 25, 1899. An *Ichthyonema*, possibly more than one, in a tangled mass beneath the skin in gill cavity; flat and ribbon-like, with eggs, but no young in uterus.

CESTODES.

4. *Larval cestode*, on pyloric cæca. **7**, pp. 278, 300, pl. XLII, fig. 100. Also see **4**, p. 789, pl. LXI, figs. 2, 3.
5. *Larval cestodes* (*Scolex polymorphus* Dujardin). Small. Free in intestine. Aug. 10, 1899; few. For account of these forms see **4**, pp. 789–792.
6. *Rhynchobothrium*. In cysts of stomach wall. **4**, p. 795. July 31 and Aug. 9, 1899.
7. *Tetrarhynchus bicolor* Bartels. **7**, p. 277. See **4**, pp. 813–815.
8. *Tetrarhynchus*. Encysted in stomach wall. **7**, p. 278.

TREMATODES.

9. *Distomum vitellosum* Linton. Intestine. See **7**, p. 290, pl. XXXVII, figs. 38, 39. Aug. 23, 1900.
10. *Gasterostomum arcuatum* Linton. **7**, pp. 277–278, 297–298, pl. XLI, figs. 85–90. July 15, 1899; from four hosts, 18; from five hosts, 22. Aug. 10, 1899; from three hosts, several. Aug. 19, 1899; 5. July 30, 1900; 36 from three fish.

These occur most commonly in the pylorus, but were found in the stomach, pyloric cæca, and intestine. In one instance both young and adult were found together in the intestine.

11. *Hexacotyle thynni* De la Roche (?). [Pl. XXVII, figs. 296–298.] Aug. 7, 1900; 1, from mouth. Collected by Mr. R. P. Cowles.

Dimensions in millimeters, specimen somewhat flattened: Length, 7.5; breadth of body, middle 2, posterior 1.9, neck 0.55; length of neck, 0.94, the anterior tip tapering to 0.15 in a distance of 0.3; each of the six sucking disks 0.46 and 0.36 in the two principal diameters.

Scomberomorus maculatus, *Spanish Mackerel.*

FOOD.

The stomachs of all the specimens which I have examined have been empty. The food habits are doubtless the same as those of the nearly related *S. cavalla*.

NEMATODES.

1. *Ascaris incurva* Rudolphi (?). Fragment, from intestine. July 30, 1900.

A female with ova developing in uterus. Dimensions in millimeters: Length, 23; diameter, 1.75; diameter at anal aperture, 0.16; distance from anal aperture to posterior tip, 0.65.

2. *Ascaris clavata* Rudolphi. Immature. From stomach. Collected by S. E. Meek, Fulton Market, New York, Aug. 30, 1886. Length of longest specimen, 40 mm.

The bodies are rather thick, tapering somewhat quickly at anterior end, less so at posterior. One ala terminates on upper lip, the other on the left lower lip. In the larger specimen the vulva was situated 14 mm. from the anterior end.

3. *Immature nematode*. Encapsuled on viscera. Aug. 13, 1889; fragment. Dimensions in millimeters: Length, 10; greatest diameter, 0.4; diameter at anal aperture, 0.13; distance of anal aperture from posterior tip, 0.45. Body crossed by fine lines, making sharply serrate outline. [Pl. XIV, fig. 172.]
4. *Ichthyonema globiceps* Rudolphi. From ovary. Collected by S. E. Meek, Oct., 1886. Fish from New Jersey coast.

The specimens were first seen by me after they had been preserved in alcohol. They are immature. The aggregate length of the fragments in the vial is 120 mm. These represent two specimens. The diameter is uniform throughout and is about 0.18 mm.

CESTODES.

5. *Synbothrium filicolle* Linton. Cysts on viscera. **4**, p. 815.
6. *Rhynchobothrium bulbifer* Linton. Cysts on viscera. July 21, 1900. See **4**, p. 793.
7. *Rhynchobothrium speciosum* Linton. Cysts on viscera. July 30, 1900. See **4**, pp. 801–805.

TREMATODES.

8. *Gasterostomum* sp. Intestine. [Pl. XXXIV, figs. 369–372.] July 21 and 30 and Aug. 13, 1900; 12 hosts in all.

This is probably a new species near *G. arcuatum*. Neck and body crossed by fine transverse striæ, which under high magnification are resolved into transverse rows of exceedingly fine, short, bristle-like spines. Dimensions in millimeters: Length, 2.1; diameter, anterior 0.2, maximum diameter, at about 1½ mm. from anterior end, 0.31; anterior sucker, length 0.14; breadth of acetabulum 0.29, length 0.26; ova, 0.017 and 0.014 in the two principal diameters. In one of the specimens there were ova of two kinds. The smaller had thick shells with dimensions as given above. These were most abundant. In addition to these there were a considerable number of larger oval eggs with thinner shells in the uterus just back of the acetabulum. The dimensions of these in life were 0.028 and 0.024 in the two principal diameters. In the preserved specimens the contrast between these ova is not so great as in life. The vitellaria are as in *G. arcuatum*, viz, 16 on each side in two lateral clusters in front of the acetabulum. Two sets of comparatively coarse diagonal fibers crossing each other (fig. 370) constitute a conspicuous feature of the body wall in the neck of a stained specimen.

9. *Distomum* (*Köllikeria*) sp. Cysts in intestinal wall. Aug. 13, 1900. [Pl. XXXIV, fig. 366.]

Only a few of these cysts were collected, it being supposed from their appearance that they contained degenerate connective tissue. All but one consisted of but little more than a mass of small ova. Dimensions in millimeters: Longer diameter of reniform mass 1.74, shorter diameter 1.09; diameter of neck (?), 0.13; ova, 0.015 and 0.01 in the two principal diameters. Color, yellow and white intermingled.

Scomberomorus cavalla, *Cero*.

FOOD.

Bones of fish, pen and other parts of squid in stomach. Stomach usually empty.

CESTODES.

1. *Synbothrium filicolle* Linton. **4**, p. 818.

Scomberomorus regalis (*Cybium regale*), *King-fish*, *Cero*.

FOOD.

Fragments of small fish in stomach. In most cases the stomach was empty.

CESTODES.

All from cysts on viscera.

1. *Rhynchobothrium* sp. **4**, p. 794. Aug. 18, 1899.
2. *Tetrarhynchus* sp. **4**, p. 808.
3. *Synbothrium filicolle* Linton. **4**, pp. 811–818. Aug. 18, 1899.

Tetrapterus imperator (*Tetrapterus albidus*), *Spear-fish*.

NEMATODES.

1. *Ascaris incurva* Rudolphi.

U. S. National Museum collection. Label: "From rectum of *Tetrapterus*, Penikese, B. G. Wilder; August 5." There are twenty-four specimens in the lot, the largest 88 mm. in length and 3 mm. in greatest diameter; diameter of head, 0.4 mm. Nematodes, probably of this species, were obtained from the intestine of a spear-fish at Woods Hole, August 8, 1885, and turned over to B. F. Koons, Mansfield, Conn.

CESTODES.

2. *Dibothrium manubriforme* Linton. Intestine. **1**, pp. 456–458, pl. I, figs. 1–4. **2**, pp. 728–731. **5**, p. 429.
3. *Tetrarhynchus* (?). Cysts on intestine. **4**, p. 809.

Istiophorus nigricans (*Histiophorus gladius*), *Sail-fish.*

CESTODES.

1. *Dibothrium manubriforme* Linton. See under *Tetrapterus imperator*, No. 2.

Xiphias gladius, *Sword-fish.*

FOOD.

Fish and squid.

NEMATODES.

1. *Ascaris incurva* Rudolphi. Stomach. [Pl. IV, figs. 29–32.]

U. S. National Museum collection; Casco Bay, Me., 1873. United States Fish Commission steamer *Albatross*, near station 2091, 1883. Woods Hole, Mass., July 25, 1885. Numerous specimens in each lot. In the last lot one of the females measures 93 mm. in length; the genital aperture is 30 mm. from the anterior end. Some small specimens, 12 mm. in length, are the young of this species. The following note was made at the time of collecting: One of the largest measured 267 mm. in length and 3 mm. in diameter. Some of the worms were of a greenish color; smaller ones, with a red-brown stripe; very small ones, hair-brown; two or three, quite dark brown.

CESTODES.

2. *Dibothrium plicatum* Rud. Intestine. **2,** pp. 746–750, pl. III, figs. 1–6. **5,** pp. 430–431. **7,** p. 278.
3. *Rhynchobothrium attenuatum* Rudolphi. Peritoneum. **4,** pp. 805–806, pl. LXV, figs. 8–11. **7,** p. 278.
4. *Tetrarhynchus bicolor* Bartels. Peritoneum and mesentery. **4,** pp. 813–815, pl. LXVIII, figs. 1–6.

TREMATODES.

5. *Tristomum coccineum* Cuvier. Gills. **6,** pp. 509–510, pl. XL, fig. 9. **7,** p. 278.
6. *Distomum clavatum* Rudolphi. Stomach. **6,** pp. 539–540, pl. LIII, figs. 8–11.

COPEPODS.

7. *Philichthys xiphiæ* Steenstrup. July 19, 1900.

Six specimens of this parasite were found by Mr. C. F. Silvester in the frontal sinuses of a sword-fish head which he was dissecting. These were females, with egg cases along the sides, held in place between the dorsal and ventral rows of lateral outgrowths of the body, and ranging in length from 14.5 to 27 mm. General color white, becoming a very faint salmon on swollen lobes toward anterior end; body along median line slightly darkened by intestine showing through. Egg masses dark olive. Dimensions of largest specimen in millimeters: Length, 27; breadth of body at anterior lobes, 8; at middle, 3; at middle including outgrowths, 10.5.

Naucrates ductor, *Pilot-fish.*

But one specimen examined; no entozoa found. **7,** p. 278.

Seriola zonata, *Pilot-fish.*

FOOD.

Stomach contents of specimen examined August 16, 1889, half digested fish, probably butter-fish.

NEMATODES.

1. *Ascaris incurva* Rudolphi. Stomach.

Two females, collected August 16, 1889. Dimensions of one in millimeters: Length, 22; diameter of head 0.19, 1 mm. back of head 0.28, maximum 0.9, 1 mm. from posterior end 0.36, at anal aperture 0.17; length of head, 0.12; distance from anal aperture to posterior tip, 0.36; distance of reproductive aperture from anterior end, 5.5.

CESTODES.

2. *Tetrarhynchus bisulcatus* Linton. Encysted, stomach wall. **4,** pp. 810–811, pl. LXVI, figs. 11–15.

Decapterus macarellus, *Mackerel Scad.*

FOOD.

Only young specimens, 5 inches and under, have been examined. Copepods found in alimentary canals of most of them; annelids were found in one lot along with copepods; about 200 fish examined in July and August, 1899 and 1900.

CESTODES.

1. *Cestode larva.* Intestines. [Pl. XX, fig. 228, *a–e.*]

Shaped something like a spool, with flaring sharp-edged flanges, but changing its shape in a remarkable manner, and its length from 1 to 4 mm. September 1, 1900.

2. *Larval cestodes* (*Scolex polymorphus* Dujardin). Small. Free in intestine. See **4**, pp. 789–792.

Found in eight out of nine lots examined. Two red spots in neck and a single costa on the bothria in specimens collected September 1, 1900.

3. *Rhynchobothrium* (?). Immature larvæ in cysts on viscera. July 31, 1899.
4. *Tetrarhynchus bisulcatus* Linton. Cyst on viscera. [Pl. XXI, fig. 243.]

A single scolex, collected August 18, 1900, resembles this species, except that the hooks are rather more slender. The borders of the bothria were provided with a band of very minute, dense, bristle-like spines. Calcareous bodies unusually abundant, mostly oblong-elliptical in outline and uniformly distributed in the parenchyma; largest 0.024 mm. in principal diameter. Diameter of proboscis, including hooks, 0.06 mm.; without hooks, 0.034 mm. Length of hooks, 0.024 mm.

TREMATODES.

5. *Distomum appendiculatum* Rudolphi. Intestine. [Pl. XXVIII, figs. 312–314.] See **7**, p. 289, pl. XXXVI, figs. 25, 26. July 31 and Aug. 2, 1899. Aug. 18 and 22, 1900; few.

These distomes were very active, and when stretched to their extreme length became almost filiform, except in the vicinity of the suckers. As these worms contract very much when they are placed in the killing fluid, unless kept compressed, but little idea of their appearance in life can be gained from a study of alcoholic specimens. One of these distomes taken August 22, 1900, revealed a structure of the vitellaria, which suggested *D. monticellii.* It was one of the smaller distomes of the lot and differed in general appearance from the larger principally in the absence of ova (see figs. 313 and 314). The dimensions of the ova in these distomes differ from those which I have recorded for *D. appendiculatum* in my report for 1898 [**7**, p. 289]. Dimensions in millimeters, life: Length 2.47; diameter of oral sucker 0.15, of ventral 0.35; ova, 0.014 and 0.01 in the two principal diameters.

6. *Distomum vittellosum* Linton. See **7**, p. 290. Aug. 2, 1899; Aug. 29, 1900.

Two distomes on former date and one on latter, with prominent acetabula, belong to the species referred to in this paper under this specific name. The one taken August 29 was compared with specimens from a young blue-fish taken on the same day, while the worms were alive, and found to agree specifically.

Trachurops crumenophthalmus, *Big-eyed Scad.*

FOOD.

Two small specimens examined August 15, 1899, had in the alimentary tracts the jaws, spines, and other fragments of annelids.

NEMATODES.

1. *Immature* (*Ascaris*). Encapsuled.

TREMATODES.

2. *Distomum appendiculatum* Rudolphi. See **7**, p. 289, pl. XXXVI, figs. 25, 26.

This is a small specimen. Length, in alcohol, 0.65 mm.; diameter, 0.26 mm. It appears to belong to the species recorded in this paper as *D. appendiculatum.*

Caranx crysos, *Yellow Crevallé.*

FOOD.

Aug. 28, 1900; 13 young examined. Shrimps very abundant in alimentary canal.

CESTODES.

1. *Rhynchobothrium.* Cysts, peritoneum. **4**, p. 794, pl. LXII, figs. 13–15.

Vomer setipinnis, *Dollar-fish.*

Examined only on one occasion, August 5, 1887. No entozoa found.

Pomatomus saltatrix, *Blue-fish.*

FOOD.

Stomachs of adult with fish (hake, herring, scup, cunner) and squid. Smaller individuals had in their alimentary canals small fish, as a rule, but shrimp and amphipods were also found.

ACANTHOCEPHALA.

1. *Echinorhynchus proteus* Westrumb. **1**, pp. 496–497, pl. VI, figs. 3–5. **3**, pp. 537–538, pl. LX, figs. 85–88. Aug. 15, 1899; July 21, 23, 1900; Aug. 13, 1900. In intestine, usually with the head perforating the intestinal walls.
2. *Echinorhynchus incrassatus* Molin. Peritoneum. **3**, pp. 533–534, pl. LVIII, figs. 54–69*a*.
3. *Echinorhynchus sagittifer* Linton. Peritoneum. **1**, pp. 493–496, pl. VI, figs. 1, 2. **3**, pp. 535–536.

NEMATODES.

4. *Immature nematodes.* Encapsuled on viscera. **7**, p. 278. Aug. 15, 1899; July 21, 23, 1900; Aug. 13, 1900. [Pl. X, figs. 100–106.]

Found also on many occasions in previous years encapsuled on the viscera. A common form is identical with that from the squeteague (fig. 107); length of one, 10.5 mm. Another common form is larger (18 mm. to 28 mm.). In the larger specimens the characteristic head of *Ascaris* may be made out through the investing membrane. The posterior end in this form is bluntly rounded with a sharp mucronate tip. A small specimen, 9 mm. in length, differed from the foregoing by having the postanal region roughened as shown in fig. 120, from *Stenotomus.*

One lot from the outer coats of the stomach, collected by S. E. Meek, Fulton Market, New York, October, 1886, represent a more advanced stage of development than the foregoing. (See figs. 100–104.) The body is thickest anteriorly and is covered with a thin embryonic investment. The large intestine ends abruptly in a short and comparatively narrow rectum, with a top-shaped anal gland on the left side and another on the dorsal side, both near the termination of the intestine proper (fig. 104). Dimensions of one in millimeters: Length, 20; diameter of head 0.14, 2 mm. back of head 0.34 maximum 0.34, 2 mm. from posterior end 0.24, at anal aperture 0.16; distance of anal aperture from posterior end, 0.26; length of œsophagus, 2.6.

5. *Ichthyonema globiceps* Rudolphi. Ovaries. [Pl. XVIII, figs. 211–215.] August, 1884.

Dimensions of alcoholic specimen in millimeters: Length, 150; diameter of globular anterior extremity of œsophagus 0.15, of œsophagus behind anterior end from 0.07 to 0.09, of intestine near œsophagus 0.04; length of œsophagus, 1; diameter of body (maximum), 1; diameter one-half millimeter from posterior end, 0.5; length of embryos from 0.2 to 0.36; greatest diameter of embryos 0.014. The color of the alcoholic specimen is yellowish white, with the intestine showing as a relatively broad, dark-brown stripe. The intestinal walls have an abundant deposit of pigment and are traversed by transparent anastomosing lines, which produce an effect which resembles the venation of a leaf. The embryos, which are in myriads, appear to have escaped into the body cavity by rupture of the uterus. They are blunt at one end and exceedingly slender, even flagellate, at the other.

CESTODES.

6. *Dibothrium crassiceps* Rudolphi.

July 21, 1900; 36 scolices obtained from one fish. The longest of the strobiles, none of which are mature, was 40 mm. Scolex nearly globular; when at rest broader than long in some. (See No. 3, under *Merluccius bilinearis.*) [Pl. XVII, figs. 142–144.]

7. *Rhynchobothrium bulbifer* Linton. Cysts on viscera. **4**, p. 793. Aug. 3, 1900.

8. *Rhynchobothrium speciosum* Linton. Cysts on viscera. **4**, pp. 801–805, pl. LXIV, figs. 13–14, and pl. LXV, figs. 1–7. **7**, p. 278. July 21, 23, 1900; Aug. 13, 1900.

9. *Tetrarhynchus bisulcatus* Linton.

Usually present in great abundance in cysts in the stomach wall; best seen by separating the muscular coats from the submucosa, when the cysts will be seen lying in the submucosa. **1**, p. 486 (*R. bisulcatus*). See also **4**, pp. 810–811. **7**, p. 278. July 21, 23, 1900; Aug. 1, 1900.

10. *Tetrarhynchus erinaceus* Beneden. Cysts on viscera. See **4**, pp. 811–812, pl. LXVII, figs. 1–8. Aug. 13, 1900.

11. *Otobothrium dipsacum* Linton. **4**, pp. 806–807, pl. LXVI, figs. 1–5.

12. *Synbothrium filicolle* Linton. Cysts on viscera. **4**, p. 818. **7**, p. 278. July 21, 23, 1900; Aug. 1, 13, 1900.

In specimen examined Aug. 1 several large cysts were found on spleen, pyloric cæca, and intestine, and one in submucosa of stomach. Cysts with degenerate contents. July 23, Aug. 11, 1900.

13. *Larval cestodes* (*Scolex polymorphus* Dujardin). Small, free in intestines. See **4**, pp. 789–792. Aug. 26, 1899; July 21, 1900.

TREMATODES.

14. *Distomum monticellii* Linton. Intestine. See **6**, pp. 518–520, pl. XLIV, figs. 2–8. July 27, Aug. 11, 14, 1899; 10 in all.

15. *Distomum* sp. [Pl. XXXI, figs. 341–344.]

Brief mention is here made of a few small distomes found on the following dates: August 14, 17, 26, 1899; August 18, 1900. They are characterized by being covered with low, flat spines as in *D. dentatum*, mouth unarmed, suckers of about equal size, and œsophagus longer than pharynx. The body is white, depressed, usually oval, but elongated forms also seen, both forms occurring in same lot. Similar forms were found in the flounder (fig. 345) and scup (fig. 346); spineless distomes agreeing in other respects with these were seen in the flounder (fig. 352), and in the butter-fish (fig. 353); a related form from the mummichog is shown in fig. 354.

16. *Distomum vitellosum* Linton. [Pl. XXX, figs. 337–339.] See **7**, p. 290, pl. XXXVII, figs. 38, 39. Aug. 26, 1899; July 21, 1900; Aug. 18, 25, 29, 1900.

I here record examples from the blue-fish of a species of distome found in a number of hosts which I have entered in my notes as small, cylindrical, with prominent acetabulum. In many cases, where tap water was used for washing out the contents of the alimentary canal, distomes were found which had been killed by contact with the fresh water. Under such conditions the distome assumed a characteristic position in which the neck was reflected nearly at right angles to the body. In sea water or in salt solution the worm remains active and is then seen to be of very varying form. The species is near *D. simplex*. See remarks under No. 6 of *Microgadus*.

17. *Microcotyle* sp. From gill filaments. [Pl. XXVII, figs. 299–306.]

Prof. C. B. Wilson, while collecting parasitic copepods from the gills of a large blue-fish, September 3, 1900, called my attention to some trematode worms. These belong to the genus *Microcotyle*. They are slender, thin, and strap-like worms, attenuate both anteriorly and posteriorly. They attach themselves to the gills by the posterior part of the body, which, for a third of its length, is provided with a great number of minute suckers. The worms were very active with the body proper, although remaining firmly attached to the gill filaments, in which position they were killed. They were transparent, bluish white, the vitellaria marginal and dark brown. They were collected just as I was about to leave Woods Hole, so that but little time was available for the study of the living worms.

Dimensions of a specimen in glycerine, measurements in millimeters: Length of body proper 4, of posterior sucker-bearing portion 4; diameter of body, maximum 1.5, of posterior sucker-bearing portion 0.57 near body and 0.37 near tip; diameter of single posterior sucker, 0.065; diameter of anterior end through suckers, 0.25; anterior suckers, two in number, 0.11 in length, 0.10 in breadth; pharynx, seen only in dorsal view, adjacent to suckers, length 0.07, breadth 0.05; length of ovum exclusive of filaments, 0.21. Length of body in another specimen, 7; maximum diameter, 1.5; length of posterior sucker-bearing portion, 4. The number of posterior suckers is about 90 in each row, or 180 in all.

Rachycentron canadus, *Cobia, Crab-eater.*

FOOD.

A specimen taken in Buzzards Bay, July 15, 1899, was kept in a large pool at the Fish Commission laboratory until August 31, when it was examined for parasites. The stomach contained large numbers of bones, mostly vertebræ of fish (squeteague, etc.) from which the flesh had been entirely digested.

NEMATODES.

1. *Ascaris inquies*, sp. nov. [Pl. VI, figs. 46–50.]

The stomach contained a large number of nematodes, which were very active and remained active for several hours in sea water. Indeed, they showed no tendency to come to rest at the time they were put in the killing fluid. While these worms have not yet been worked up, the following brief characterization may be given in this preliminary report. The general color of the body in life was dark ashy brown; head and anterior part of the body to the base of the œsophagus white. Jaws prominent, head wider than neck, which is sharply serrated, being crossed by fine transverse lines at regular intervals. Posterior end acuminate. The preanal papillæ appear to be about 24 on each side, the posterior 10 of these small; postanal papillæ not seen distinctly, probably 4, very small. The following measurements of a female in acetic acid are given in millimeters: Length, 40; length of œsophagus, 2.47; length of head 0.16, breadth 0.29; diameter of neck at head, 0.16; maximum diameter of body near posterier end, 0.8; diameter 1 mm. from posterior end, 0.44; diameter at anus, 0.44; distance of anus from posterior tip, 0.51; distance between striæ on neck, 0.024.

Coryphæna hippurus, *Dolphin.*

The specimens which were brought into the laboratory had been eviscerated so that only cestodes encysted on the peritoneum were seen. The nematodes mentioned here are from the U. S. National Museum collection.

NEMATODES.

1. *Ascaris increscens* Molin. Stomach. Collected June 24, 1887. [Pl. VIII, figs. 62–64.]

Dimensions of one of the largest in millimeters: Length, 43; diameter of head 0.17, 2 mm. back of head 0.24, middle 0.7, at anal aperture 0.28; distance from anal aperture to posterior tip, 0.34; length of male spicules, 3. Tip of tail of one mucronate with short spines. These specimens are referred to this species provisionally.

CESTODES.

2. *Rhynchobothrium* sp. [Pl. XXI, figs. 239, 240.]

August 23, 1899. From large blastocyst 30 mm. in length, 5 mm. in diameter at anterior end, tapering to point at posterior end. The larva measured 15 mm. in length. The hooks of this specimen were not seen, but the general appearance of the larva, as well as of its blastocyst, is much like that of *R. speciosum.*

3. *Tetrarhynchus bicolor* Bartels. **4,** pp. 813–815, pl. LXVIII, figs. 1–6.

Also found both free and encysted on peritoneum of two dolphins, Aug. 23, 1899. Pedunculated cysts with network of capillaries on exterior, when opened, liberated an active larva.

TREMATODES.

4. *Distomum tornatum* Rudolphi. **6,** pp. 513, 514, pl. XLII, figs. 6–12. See No. 3 under *Menidia notata.*

Palinurichthys perciformis, *Rudder-fish.*

FOOD.

Squid, small crustaceans, univalve mollusks. (**7**, p. 279.) Salpa and a slender green alga found in the alimentary tracts of two fish from Menemsha, September 1, 1900.

ACANTHOCEPHALA.

1. *Echinorhynchus pristis* Rudolphi. Intestine. (Variety *tenuicornis.*) **3**, pp. 531–532, pl. LVI, figs. 39–41, and pl. LVII, figs. 42–53. **7**, p. 279.

CESTODES.

2. *Larval cestodes* (*Scolex polymorphus* Dujardin). Free in alimentary tract. **4**, pp. 789–792, pl. LXI, figs. 4–15. **7**, p. 279. Found also Sept. 1, 1900.

TREMATODES.

3. *Distomum pyriforme* Linton. Intestine. **7**, pp. 279, 292–293, pl. XXXVIII, figs. 52–59. Found Sept. 1, 1900.

Rhombus triacanthus (*Stromateus triacanthus*), *Butter-fish.*

FOOD.

Stomachs of larger fish usually empty, but a few fragments of fish occasionally seen. In the alimentary tracts of smaller specimens copepods, annelids, and small fish were found. Sept. 1, 1900, 25 small fish were examined. The food consisted principally of amphipods.

ACANTHOCEPHALA.

1. *Echinorhynchus sagittifer* Linton. July 24, 1900. Encapsuled on viscera. See **1**, pp. 493–496, pl. VI, figs. 1, 2. **3**, pp. 535–536, pl. LIX, fig. 80.

NEMATODES.

2. *Cucullanus* sp.

U. S. National Museum collection; Vineyard Sound; V. N. Edwards, collector. One female, with segmenting ova; œsophagus sinuous; body of nearly same diameter throughout. Dimensions in millimeters: Length, 9; diameter, 0.38; length of œsophagus, 0.5; diameter of œsophagus 0.05, at anterior end 0.09; diameter of head, 0.12.

3. *Immature nematodes.* On viscera. [Pl. XII, figs. 132, 133.] **7**, p. 279.

Very abundant. Found in the majority of specimens examined in 1899 and 1900; small, pale red; particularly abundant on pyloric cæca. A specimen found in the stomach of a sea bass yielded a large number of these worms. If the process of digestion had proceeded a little further, the sea bass would have been the accredited host of these nematodes. Dimensions in millimeters: Length, 13; diameter, head 0.14, 1 mm. from head 0.28, maximum (toward posterior end) 0.34, 1 mm. from posterior end 0.28, at anal aperture 0.23; distance from anal aperture to posterior end, 0.36.

CESTODES.

4. *Rhynchobothrium.* Cysts on viscera. **7**, p. 279. Numerous examples were found in the summers of 1899 and 1900.

An interesting case of abnormality was noted in a specimen collected July 27, 1899. Only one-half the larva—i. e., one bothrium with its pair of proboscides, including the contractile bulbs—was present. This could not have been a case of mutilation, since it was seen to be abnormal when it issued from the blastocyst while under the compressor. The hooks on the retracted proboscides of this specimen resemble those of *R. bulbifer.*

5. *Rhynchobothrium.* Cysts in muscles. [Pl. XXIII, figs. 255–256*a*, and pl. XXIV, fig. 265.]

On August 26, 1899, two butter-fish, which had been cleaned and prepared for the table, were submitted to me by Dr. F. Judson Herrick, who, after having had an opinion rendered regarding their condition, decided to allow them to be devoted to the cause of science. The muscles between the ribs contained great numbers of small cysts. When one of these was compressed, a blastocyst was liberated,

from which, upon further pressure, a larval cestode (*Rhynchobothrium* sp.) could be obtained. Forty of these cysts were counted in a space 4 mm. square.

Similar conditions were observed in a butter-fish brought to me by Mr. E. E. Tyzzer, August 17, 1900, and in another examined the following day.

In these cases enormous numbers of cysts were seen in the muscles. They were most abundant on the ventral side of the vertebral column, between the subvertebral spines. They were also scattered through the dorsal region, lying deep among and near the dorsal vertebral spines. The cysts are small, oval, about 1 mm. in length and somewhat less in shorter diameter. One measured 1.3 mm. in length and 0.87 mm. in diameter. The contained blastocyst measured 0.87 and 0.67 mm. in the two principal diameters. Dimensions of the larva in millimeters: Length, 0.7; bothria nearly circular, 0.3 in diameter; diameter of neck, 0.1. Contractile bulbs very short.

6. *Tetrarhynchus.* Cysts on peritoneum. **4**, p. 809. Some of these may belong to the genus *Rhynchobothrium.*
7. *Tetrarhynchus erinaceus* Beneden. See **4**, pp. 811–812, pl. LXVII, figs. 1–8. July 27, 1900; several on viscera.
8. *Larval cestodes* (*Scolex polymorphus* Dujardin). Free in intestine. See **4**, pp. 789–792. Found in summers of 1899 and 1900.
9. *Dibothrium angustatum* Rudolphi. Sept. 1, 1900. A few small specimens, the longest less than 10 mm. in length; head about 1 mm. long and 0.3 mm. or less in width. Very active. Joints narrow and irregular. Immature.

TREMATODES.

10. *Distomum gulosum* sp. nov. [Pl. XXVIII, fig. 315–317.]

Appendiculate distomes, apparently new. July 26, 1899; 16 specimens obtained from a lot of 4 butter-fish. Butter-fish were examined on seventeen different occasions in 1899 from July 17 to August 26. Dimensions of living specimens, slightly compressed, in millimeters: Length, 10; maximum diameter, median, 1.14; length of appendix, 3.6; diameter of anterior sucker 0.36, of acetabulum 0.38; distance between suckers, 0.1; diameter of testes 0.47, of ovary 0.28; ova, 0.017 and 0.010 in the two principal diameters.

Body slender; neck tubular, slightly arcuate; neck and anterior part of body crossed by fine lines, which produce a sharply serrate outline; oral sucker nearly globular; mouth slightly subterminal, with longitudinal opening; pharynx tubular, almost as long as the oral sucker; œsophagus none; intestinal rami extending into the appendix, which is long and slender; genital aperture on ventral border of mouth; acetabulum nearly globular, its diameter not differing much from that of the oral sucker; seminal vesicle some distance behind acetabulum, followed posteriorly by the two smallish subglobular testes, which lie end to end; ovary globular, a short distance behind the testes; vitellaria about the middle of the body, behind the testes, tubular, as many as six tubules showing in sections; uterus voluminous, its folds extending into the appendix; ova numerous, small. Dimensions of a specimen mounted in glycerine, in millimeters: Length, 7.5; oral sucker, length 0.36, breadth 0.36; pharynx, length 0.33, breadth 0.18; acetabulum, length 0.32, breadth 0.33; distance from anterior end to acetabulum, 0.87; distance between acetabulum and testes, 1; distance between testes and ovary, 0.19; diameter, of neck 0.36, middle of body 0.65, posterior 0.15, of anterior testis 0.28, of posterior testis 0.25, of ovary 0.23; ova, 0.017 and 0.010 in the two principal diameters.

The alcoholic specimens show at least one important variation from the living worm, viz, in the relative size of the suckers. In one the suckers were of equal size, in another the acetabulum was less, and in another the anterior sucker was larger but of less transverse diameter than the acetabulum. The vitellaria are tubular, showing as many as six distinct masses in transverse sections of the body.

11. *Distomum* sp. [Pl. XXXII, fig. 353.]

Mention is here made of a few small distomes which require further study before a specific name can be assigned to them. Specimens were found on July 24 and August 14 and 23, 1899, which were small, oval, translucent, bluish-white, and spinose. Dimensions of a living specimen in millimeters: Length, 0.78; diameter of oral sucker, 0.064; of ventral sucker, 0.057.

These specimens suggest *D. pyriforme.* Others collected July 26 and August 2, 15, 20, and 23, 1899, resemble these, but the habit of the body is much more slender. [Fig. 353.] Some of these suggested *Distomum* sp. from the scup [**7**, p. 296, pl. XXXIX, fig. 72], and *Distomum* sp. from the puffer [**6**, pp. 537–538, pl. LIII, figs. 1, 2]. Spines can not always be made out on these forms.

Dimensions of specimen sketched (fig. 353), life, in millimeters: Length, 1.46; diameter, anterior 0.1, middle 0.27, of oral sucker 0.07, of ventral sucker 0.07; ova, 0.075 and 0.058 in the two principal diameters. See also figs. 341–346, 352, 354.

PROTOZOA.

12. *Sporocyst*

From liver: White, globular, 1.5 mm. in diameter. When compressed it liberated immense numbers of spores, which were in large part aggregated into globular or oblong clusters, the larger as much as 0.02 mm. in diameter. The spores were short and thick, with bluntly rounded ends; length about 0.0025 mm., and a little less than that in breadth and thickness. Collected September 1, 1900. Specimen given to Dr. H. H. Cushing.

Roccus lineatus, *Striped Bass.*

FOOD.

The stomachs of all the specimens which I have examined have been empty. A few fish scales have been noted in the intestine.

ACANTHOCEPHALA.

1. *Echinorhynchus proteus* Westrumb. **1,** pp. 496–497, pl. VI, figs. 3–5. **3,** pp. 537–538, pl. LXVIII, figs. 85–88. July 14, 1900; 2 fish examined, 20 in one, 6 in the other. Two obtained from another July 21.

This parasite is apparently with rare exceptions always present in the rectum of the striped bass. Usually the head of the worm perforates the intestinal wall and is often surrounded by a waxy secretion, which is covered by the serous coat.

2. *Echinorhynchus acus* Rudolphi. **1,** pp. 492–493, pl. V, figs. 7–13. **3,** pp. 525–528, pl. LIII, figs. 1–11, and pl. LX, figs. 89, 90.

NEMATODES.

3. *Ascaris* sp. Immature.

In a striped bass examined August 18, 1887, numerous small capsules were found between the mucous and submucous layers of the stomach. These were more or less elongated, some even vermiform, and were dark-brown on account of the waxy, degenerate tissue with which they were surrounded. These capsules contained nematodes. The head of the one examined was truncate, with indistinct papillæ. The tail tapers to a smooth, round point, somewhat elongate behind the anal aperture. The body is crossed by exceedingly fine striæ. The œsophagus is long, with a cæcal appendage at its base. These forms resemble those from the squeteague. [Figs. 107–109.]

4. *Filaria rubra* Leidy.

From flesh. Collected by S. E. Meek, Fulton Market, New York, August 12, 1886, who says that the worm was red when living. The specimen is a fragment, the posterior end of a long worm; linear, slightly roughened by transverse wrinkles; length, 60 mm.; diameter, about 1 mm.

5. *Lecanocephalus annulatus* Molin. [Pl. XIX, figs. 220–223.]

One specimen, a male, from peritoneum, August 3, 1889. The specimen was in poor condition and but little more than the external characters could be made out. Some of the dimensions in millimeters are given: Length, 8; diameter of head 0.19, 1 mm. back of head 0.46, maximum (about middle) 0.61; length of copulatory spines, about 0.11; distance between the transverse dentigerous rows, about middle of body, 0.03.

CESTODES.

6. *Rhynchobothrium speciosum* Linton. See **4,** pp. 801–805, pl. LIV, figs. 13, 14, and pl. LXV, figs. 1–7. July 21, 1900. Elongated cyst on viscera.

TREMATODES.

7. *Distomum tornatum* Rudolphi. Intestine. [*D. rufoviride* Rudolphi.] **6,** pp. 515–517, pl. XLII, fig. 14, and pl. XLIII, figs. 1–4.

These specimens were wrongly identified. They should be referred to *D. tornatum.*

8. *Distomum tenue* Linton. **6,** pp. 535–536, pl. LII, figs. 2–8.

9. *Cysts in liver.* [Pl. XXVII, figs. 308, 309.]

These cysts, collected July 14, 1900, are a deep red brown, almost black by reflected light. They are globular, except where they lie so close as to touch each other. When cleared in acetic acid their structure is seen to be concentric. A granular nucleus of deeper color than the surrounding parts could be made out in each, but could not be identified. In one case two nuclei were seen. Those measured varied from 0.21 to 0.81 mm. in diameter, with the exception of one, a very small cyst, which lay touching a larger one and was flattened on the touching side, whose two principal diameters were 0.06 and 0.1 mm., respectively. It would appear that the tissues of this fish habitually build colloid cysts around foreign particles. A thin outer layer of the cyst is lighter colored than the inner part, and is evidently unmodified connective tissue. The smaller cysts have essentially the same structure as the larger. They are all confined to the surface of the liver.

Morone americana (*Roccus americanus*), *White Perch.*

FOOD.

Fish, shrimps, and other crustaceans.

ACANTHOCEPHALA.

1. *Echinorhynchus agilis* Rudolphi. Intestine. **1,** pp. 490–492, pl. V, figs. 1–6. **3,** pp. 534–536, pl. LIX, figs. 70–72.
2. *Echinorhynchus thecatus* Linton. **3,** pp. 528–529, pl. LIV, figs. 12–22.

TREMATODES.

3. *Distomum tenue tenuissime* Linton. Peritoneum. **6,** pp. 536–537, pl. LII, figs. 9–12.
4. *Distomum areolatum* Rudolphi. Intestine. **7,** pp. 279, 293–294, pl. XXXIX, figs. 60–63.
5. *Cysts with trematode ova.* Liver, etc. **6,** p. 537. **7,** p. 279.

Centropristes striatus (*Serranus atrarius*), *Sea Bass, Black Bass.*

FOOD.

Fish, squid, crabs (*Eupagurus, Panopeus, Platyonichus,* etc.).

ACANTHOCEPHALA.

1. *Echinorhynchus serrani.* Peritoneum. **3,** pp. 534–535, pl. LIX, figs. 73–79.
2. *Echinorhynchus sagittifer* Linton. Peritoneum. See **1,** pp. 493–496, pl. VI, figs. 1, 2. **3,** pp. 535–536, pl. LIX, fig. 80. July 30, 1889; in cysts on viscera.
3. *Echinorhynchus proteus* Westrumb. See **1,** pp. 496–497, pl. VI, figs. 3–5. **3,** pp. 537–538, pl. LX, figs. 85–88. Found among cysts collected in 1884.

NEMATODES.

4. *Immature nematodes* (*Ascaris*).

Found frequently in the mesentery, often very abundant. General characters are nearly uniform diameter, tapering at each end; tail mucronate. Agree with forms found in *Pomatomus, Cynoscion,* etc. Twenty-three bass, examined July 30, 1889, had each a large number of these worms, in most cases in a tangled mass on the mesentery and pyloric cæca. Many of these might be referred to the indefinite species *Ascaris capsularia.*

5. *Filaria rubra* Leidy. [Pl. XV, figs. 188–191.]

Found under the skin of a bass, Washington, D. C., October, 1891. Collected by Miss Sophia Oberheimer. The worm was bright red when alive. Dimensions of alcoholic specimen, in millimeters: Length, 125; diameter of head 0.4, 5 mm. from anterior end 0.65; median 0.8, 5 mm. from posterior end 0.75, one-half millimeter from posterior end 0.4.

CESTODES.

6. *Rhynchobothrium,* larvæ encysted on viscera. **4,** p. 793, pl. LXII, fig. 12. **7,** pp. 279–280. Aug. 4, 1900.
7. *Rhynchobothrium imparispine* Linton. On viscera. **4,** pp. 799–801, pl. LXIV, figs. 9–12.
8. *Larval cestodes* (*Scolex polymorphus* Dujardin). Free in intestine. See **4,** pp. 789–792. Aug. 4, 1900.

Lobotes surinamensis, *Flasher*.

ACANTHOCEPHALA.

1. *Echinorhynchus pristis* Rudolphi. Intestine. Variety *tenuicornis*. **3,** pp. 531–532, pl. LVI, figs. 39–41, and pl. LVII, figs. 42–53.

NEMATODES.

2. *Immature nematode* (*Ascaris*). Intestine. Collected Aug. 6, 1887. [Pl. XII, figs. 140–142.]

The worm is finely wrinkled transversely, tapers equally to head and tail; the tip of the latter is conical and covered with minute bristle-like but short papillæ. Dimensions in millimeters: Length, 11.25; diameter of head 0.12, 1 mm. back of head 0.32, maximum 0.34, 1 mm. from posterior tip 0.27, at anal aperture 0.11; length of upper lip, 0.08; distance from anal aperture to posterior tip, 0.11; length of œsophagus, 2.16.

3. *Ichthyonema globiceps* Rudolphi. Peritoneum. Aug. 3 and 6, 1887. [Pl. XVIII, figs. 209, 210.]

Two specimens in the first lot, 510 mm. and 580 mm. in length and 1.48 mm. in diameter. They are of nearly uniform diameter throughout and bluntly rounded at each end. The intestine is dark-brown for two-thirds of its length, white for the remaining third. It ends blindly at its posterior extremity. When the worm was subjected to pressure the young were discharged in vast numbers from a point about 1 mm. from the anterior end.

Dimensions of embryos in millimeters: Length, 0.4; diameter at larger end 0.008, maximum 0.013; smaller end attenuate, appearing as a mere line even when highly magnified. There are four dark-brown granular masses scattered along the middle region of the body and among them several light-colored refractile bodies. A slight notch was noticed at the larger end of some. A favorite position is with the larger end bent rather sharply; the slender end is often likewise bent, so that the two ends point toward each other. Where they occur in the greatest abundance in the parent worm they give to the latter a plump, even distended, appearance. After they have been discharged the parent is transparent, collapsed, much contracted, and quite irregular in outline, in places flattened and shriveled. The larger end is said to be the anterior. I was not acquainted with this assertion at the time of viewing the living worms, but supposed from the appearance and behavior of these embryos that the slender end is the anterior.

CESTODES.

4. *Synbothrium filicolle* Linton. On viscera. **4,** p. 815.

TREMATODES.

5. *Gasterostomum ovatum* Linton. Intestine. **7,** p. 297. (Linton: *Monostomum orbiculare* Rudolphi. **6,** pp. 541–542, pl. LIV, figs. 2–5.)

Stenotomus chrysops, *Scup*.

FOOD.

A few food notes were given in my report for 1898, pages 280–281. In the summer of 1899 I examined 58 large and 51 small scup on 17 different occasions from July 20 to August 30. In the stomachs of the larger, small fish and squids were most frequently found, but annelids, crabs, shrimps, amphipods, mollusks, and hydroids were also noted. The smaller contained copepods and other small crustaceans. Some small specimens from Katama Bay, August 30, had in their stomachs annelids, small crustacea, and small crepidulæ.

Twenty-six scup were examined in the summer of 1900, with practically the same results as given above, viz, fish, small crustacea of various kinds, annelids, small bivalve mollusks, and a young sea-urchin. Intestinal contents of a specimen taken August 29 revealed plates from the body walls of a holothurian. A few ova of *Distomum pyriforme* were seen in this material along with the holothurian plates, spines of annelids, and vegetable débris.

ACANTHOCEPHALA.

1. *Echinorhynchus acus* Rudolphi. On viscera. **3,** p. 527.
2. *Echinorhynchus sagittifer* Linton. July 24, 1900. See **1,** pp. 493–496, pl. VI, figs. 1, 2. **3,** pp. 535–536, pl. LIX, fig. 80.

NEMATODES.

3. *Ascaris* sp. [Pl. VIII, figs. 65–69.]

A small lot of ascarids in the U. S. National Museum collection from a scup which had been taken from the stomach of a cero (*Scomberomorus regalis*). These are thickest about the middle, rather more slender anteriorly than posteriorly; lateral alæ for about 1 mm. back of head; tail somewhat slender and prolonged beyond the anal aperture, decidedly appressed; body crossed by fine transverse lines, best seen toward posterior end. Dimensions in millimeters: Length, 45; diameter of head, 0.23, 4 mm. back of head 0.48, 10 mm. back of head 0.68; median, 1.28, 1 mm. from posterior end 0.45, at anal aperture (ventral view) 0.28; distance of anal aperture from posterior end, 0.85.

4. *Immature nematodes* (*Ascaris*). [Pl. X, figs. 110–116; pl. XI, figs. 117–120.]

Very common in body cavity on viscera. Found in at least 75 per cent of the scup examined in the past two summers; also noted repeatedly in previous years. A careful study of these forms is needed in order to fix their position. Some of them with the characteristic head of *Agamonema*, after the removal of the cuticle, revealed the unmistakable jaws of *Ascaris*. Measurements of one are given in **7**, p. 280. I add, for the purpose of comparison, measurements in millimeters, of a specimen from the viscera of a scup collected July 24, 1899: Length, 20; diameter, anterior 0.12, middle 0.5, at anal aperture 0.24; diameter of œsophagus, anterior 0.07, middle 0.08, base 0.12; length of œsophagus, 1.25; distance to nerve ring 0.57; distance of anal aperture from posterior end 0.45. In this specimen there was an intestinal diverticulum, short, bifurcate, prolonged cephalad, and a longer, more slender prolongation of the œsophagus. These immature forms are probably identical with those in the bluefish, squeteague, and others. Figures 117, 118 are sketched from a specimen collected by Mr. R. E. Earll, at Charleston, S. C., March, 1880. The capsules were mostly club-shaped, arcuate, or straightish; cuticle very finely transverse striate. Length, 22 mm.; diameter, 0.33 mm.

CESTODES.

5. *Rhynchobothrium imparispine* Linton. Encysted on viscera. Found in 1899. See **5**, pp. 799–801.
6. *Rhynchobothrium speciosum* Linton. On viscera. **5**, p. 802.
7. *Rhynchobothrium*. Encysted on viscera. **5**, p. 796, pl. LXIII, figs. 10–13. **7**, p. 280. Found in 1899 and 1900 in a large proportion of the scup examined.
8. *Tetrarhynchus bisulcatus* Linton. Stomach wall. **5**, p. 810.
9. *Larval cestodes* (*Scolex polymorphus* Dujardin). Free in intestine. **7**, p. 280. See **4**, p. 791. Seen frequently in 1899 and 1900.

TREMATODES.

10. *Distomum vitellosum* Linton. [Pl. XXX, figs. 333, 334.] See **7**, p. 290, pl. XXXVII, figs. 38, 39.

Seen often in 1899 and 1900, but always in small numbers. I append notes made on a specimen taken August 23, 1900. Worm small (1.2 mm. when at rest), very active while in sea water and salt solution, neck extremely mobile, stretching to thread-like thinness and contracting until the suckers were close together; general outline, proportions, and appearance of the body undergoing constant and perplexing changes; acetabulum much larger than oral sucker and kept expanded, i. e., its walls when the specimen was viewed from the side forming a semicircle or widely open C. When placed in fresh water the worm soon became turgid, with neck reflected, acetabulum contracted until its walls were close together, and distinctly pediceled. See under *Clupea harengus*, *Paralichthys dentatus*, etc.

11. *Distomum* sp. [Pl. XXXI, fig. 346.]

I here place certain small distomes, which appear to be near *D. pyriforme*, if not identical with that species, but until more material is available and a careful comparative topographical study of these small forms can be made it will be better perhaps to leave them without specific designation for the present. These are small, usually oval, flattened, white distomes, with minute spines. They were most numerous in small scup, seen frequently (but in small numbers) in this and other hosts. The identification of these distomes is difficult, on account of the spines, which apparently fall off easily. See No. 21 under *Paralichthys dentatus*, No. 11 under *Rhombus triacanthus*, and No. 15 under *Pomatomus saltatrix*. One of these distomes, collected August 29, 1900, was placed under slight pressure and seen in favorable conditions. Spherical bodies with concentric structure were present in the excretory vessels, and the cirrus was seen to be spinose. A cell from the germ gland was seen entering the shell mold. It appeared to be attached by a slender pedicel for a few seconds. It was surrounded by

spermatozoa, which were in active motion. Small masses of yolk, smaller than the germ cell, were also seen entering the mold. The distome noted in **7**, p. 296, pl. XXXIX, fig. 72, is a closely related form. See also No. 3 under *Lagocephalus lævigatus.*

12. *Distomum appendiculatum* Rudolphi. **7**, p. 289, pl. XXXVI, figs. 25, 26. One specimen found in this host Aug. 9, 1899.
13. *Globular cysts in kidneys.* **7**, pp. 280, 301. These are probably due to psorosperms.

RHYNCHOBDELLIDA.

14. *Pontobdella rapax* Verrill. **7**, p. 280. See under *Paralichthys dentatus*, No. 23.

Archosargus probatocephalus, *Sheepshead.*

ACANTHOCEPHALA.

1. *Echinorhynchus proteus* Westrumb.

Several specimens enveloped in connective tissue cysts from peritoneum of a fish from Chesapeake Bay. Collected by S. E. Meek, Fulton Market, New York, August 30, 1886. Several of the cysts contained degenerate connective tissue of a waxy consistency. The specimens were adult, the females containing the fusiform embryos characteristic of the species. One of the longer specimens measured 10.5 mm. in length.

Cynoscion regalis, *Squeteague, Weak-fish.*

FOOD.

Only large specimens were examined. The food is fish and squids; shrimps and amphipods found in a few cases. From the stomach of a specimen of average size, about 18 inches in length, examined July 31, 1900, there were taken two menhaden, each 9 inches long, one butter-fish, $4\frac{1}{2}$ inches long, and one squid, 7 inches in length. A specimen examined on August 1, length 20 inches, had a menhaden 11 inches long in its stomach.

ACANTHOCEPHALA.

1. *Echinorhynchus sagittifer* Linton. On viscera. **1**, pp. 493–496, pl. VI, figs. 1, 2. **3**, pp. 535–536, pl. LIX, fig. 80.
2. *Echinorhynchus proteus* Westrumb. Intestine. **1**, pp. 496–497, pl. VI, figs. 3–5. **3**, pp. 537–538, pl. LX, figs. 85–88. **7**, pp. 280–281.

Found three times in 1899 and twice in 1900. Heads perforating intestinal walls as in *Roccus lineatus.* [Pl. II, figs. 12, 13.]

3. *Echinorhynchus pristis* Rudolphi. **3**, pp. 530–531, pl. LVI, figs. 31–38.

One found on viscera July 25, 1900. While the worm was living it was observed everting and inverting both the proboscis and the anterior end of the body. These movements were rapid, especially those of the proboscis.

NEMATODES.

4. *Immature nematodes.* [Pl. X, figs. 107–109.] **7**, pp. 280–281.

On many occasions and in different summers I have found immature nematodes encapsuled in the mesentery and on the viscera. They were found in practically all the squeteague (92) examined in the summers of 1899 and 1900. These agree in the main with those found in the blue-fish, scup, and others. The largest specimens measured 17 mm. in length. A rudimentary three-lobed structure of the head could be made out in some by examination under pressure in acetic acid. A diverticulum of the intestine near the base of the œsophagus was observed in several of the specimens. Dimensions of specimen figured in millimeters: Length, 10; diameter, 1 mm. from anterior end 0.24, 1 mm. from posterior end 0.22, maximum (at anterior fourth) 0.3, at anal aperture 0.08; distance of anal aperture from posterior end, 0.12. Length of œsophagus, in a specimen 14 mm. in length, 3 mm.

CESTODES.

5. *Larval cestodes* (*Scolex polymorphus* Dujardin). Free in gall bladder and cystic duct. **1**, pp. 453–454, pl. VI, figs. 6–9. **4**, pp. 789–792, pl. LXI, figs. 4–15. **7**, pp. 280–281.

Found almost invariably in fish examined in 1899 and 1900; also free in intestine of squeteague. These are always smaller than those from the cystic duct.

6. *Rhynchobothrium.* Encysted on viscera. **4**, p. 794, pl. LXIV, fig. 1, and p. 798. **7**, pp. 280–281. Usually on the viscera (1899, 1900), associated with immature nematodes and of several species.

7. *Rhynchobothrium speciosum* Linton. Larvæ encysted on viscera. **4**, pp. 801–805, pl. LXIV, figs. 13, 14, and pl. LXVI, figs. 1–7.

8. *Rhynchobothrium bulbifer* Linton. Encysted on viscera. See **1** (*R. tenuicolle* Rudolphi), pp. 486–488. **2**, pp. 825–829, pl. X, figs. 8, 9. **4**, p. 793. **5**, p. 448. Aug. 6, 1900.

9. *Tetrarhynchus bisulcatus* Linton. Encysted in stomach wall. **4**, pp. 810–811, pl. LXVI, figs. 11–15. **7**, pp. 280–281. In submucosa of stomachs almost always present (1899 and 1900). [Pl. XXIII, fig. 261, and pl. XXIV, figs. 262–264.]

10. *Tetrarhynchus erinaceus* Beneden. On viscera. **4**, pp. 811–812, pl. LXVII, figs. 1–8. **7**, p. 281.

11. *Synbothrium filicolle* Linton. On viscera. **4**, pp. 815–820, pl. LXVIII, figs. 7–12. Noted in a few cases in 1899.

11*a*. See pl. XX, fig. 230 and description of same, for brief account of a larval cestode from a squid in the stomach of a squeteague. This form is related to the genus *Thysanocephalum*.

TREMATODES.

12. *Distomum appendiculatum* Rudolphi. Intestine. See **7**, p. 289, pl. XXXVI, figs. 25, 26. Found in this host July 25 and Aug. 5, 1899.

13. *Distomum vitellosum* Linton. Intestine. See **7**, p. 290, pl. XXXVII, figs. 38, 39.

Found once in July, 1899, four times in July and August, 1900; rather numerous. The difference in appearance between a specimen in sea water or salt solution and the same specimen in fresh water is very great. See under *Stenotomus*, *Paralichthys*, etc.

14. *Distomum pyriforme* Linton. Intestine. See **7**, p. 290, pl. XXXVIII, figs. 52–59.

Small oval distomes; body covered with minute spines; acetabulum and oral sucker nearly equal; testes median, one behind the other; ova few and large; found twice in 1899 and twice in 1900; appear to belong to this species.

15. *Distomum polyorchis* Stossich. [Pl. XXXIII, figs. 363–365.]

On five occasions in the summer of 1900 distomes were found in the pyloric cæca of the squeteague, which agree very closely with this species. The synopsis of the species given by Stossich is as follows: Body flattened, elliptical, rounded at the extremities. Anteriorly the surface is covered with conical spines set in transverse series. The acetabulum is situated at the anterior third, is somewhat smaller than the oral sucker and prominent. The oral sucker is terminal, globular, and its small aperture circular. It is joined by a slender canal with the pharynx, which is very large and of quadrangular form. There is no œsophagus. Immediately behind the pharynx the intestine divides into two branches which extend to the posterior end of the body; anteriorly, however, each branch is prolonged into a cæcum which extends as far as the anterior border of the pharynx. That which characterizes the species more particularly is the large number of testes. Some of the worms contain 24 placed in two series longitudinally in the middle of the body. The cirrus pouch is club-shaped, large, and forms an arch at the right side of the acetabulum. In it is the seminal vesicle, divided into two unequal parts by a constriction. The vitelline glands occupy all the posterior part and sides of the body and extend laterally as far as the bifurcation of the intestine. They empty into two longitudinal canals which are joined with each other by a transverse median canal, which is provided with a vitelline receptacle of rectangular shape. The oviduct, situated between the acetabulum and the testes, contains minute ova, elliptical and of a yellowish-brown color. The aperture is beside the anterior margin of the acetabulum. Length, 3.5 mm. to 6.5 mm.; breadth, 1 mm. to 1.5 mm. Bull. d. Soc. Adv. d. Sci. Nat. Trieste, vol. XI, 1889, tav. XIV, fig. 61 [p. 2 of extract].

The number of the testes was variable in my specimens. The following numbers were noted. In each case the number in the right row is placed first: 15–15; 15–12; 14–16, two; 14–15, three; 14–13, two; 14–12, two. It is to be understood that each of these testes is either double or two-lobed, a point that will be settled when the specimens are sectioned.[1] The process of egg making was observed in

[1] Sections show that the testes are double; in other words, that they are placed in four instead of two longitudinal series, two dorsal and two ventral; further, that the intestinal rami in the posterior and median portions of the body have numerous short branches.

this species and was essentially like the process observed in *Epibdella bumpusii* (**7**, p. 287). At intervals of about twenty seconds a mass of yolk could be seen to leave the yolk reservoir and proceed the short distance required to reach the definite point in the duct where an active muscular organ molded a shell around the mass. It was then forced forward into the uterus. The lobed ovary, shell gland, yolk reservoir, and beginnings of the uterus are so closely crowded together that further details of the process could not be made out. Length of these specimens (alcoholic) 4 to 7.5 mm.

COPEPODS.

16. Mention may be made also, among entozoan parasites of the squeteague, of a copepod found beneath the skin of the opercular bone, by Mr. E. E. Tyzzer. **7**, p. 285, pl. XXXIII, figs. 1–5.

Sciænops ocellatus, *Red Drum.*

NEMATODES.

1. *Ascaris* sp. [Pl. VIII, figs. 79, 80, and pl. IX, figs. 81–83.]

Collected by S. E. Meek, Fulton Market, New York, from fish taken off Sandy Hook, September 8, 1886. Three males and two females and four small, slender, immature. Habit of body in larger specimens, stout. Dimensions of female in millimeters: Length, 56; diameter of head 0.41, 1 mm. back of head 0.56, maximum 1.8, 1 mm. from posterior tip 0.9, at anal aperture 0.56; distance of anal aperture from posterior end, 0.65; length of œsophagus, 6.5. These dimensions include the loose cuticular membrane. Œsophagus in females somewhat linear-fusiform, with its greatest diameter about its posterior third; in the males somewhat flask-shape, and 2.25 mm. in length in a specimen measuring 20 mm. in length. Largest male, 27 mm. in length. Four postanal and twenty-nine preanal papillæ were counted on the left side, and two postanal and twenty-nine preanal on the right side. Length of spicules about 2 mm.

2. *Ascaris* sp. Immature. [Pl. XII, figs. 134–137.]

Probably young of No. 1, encapsuled in peritoneum. Tail blunt, rounded, with mucronate tip; œsophagus long and linear; intestine dark-brown. Dimensions in millimeters: Length, 16; greatest diameter, 0.43; length of œsophagus, 2.65.

Menticirrus saxatilis, *King-fish.*

FOOD.

Twenty-seven small specimens were examined on five occasions in July and August, 1899, and one large specimen August 3, 1900. July 28, 1899; intestines filled with small amphipods, isopods, and shrimps. August 5, 1899; small crustaceans. August 7, 1899; shrimps, amphipods, isopods, annelids. August 8, 1899; large shrimp with eggs on swimmerets, young fish, and bryozoa. August 28, 1899; annelids. August 3, 1900; pieces of fish, bryozoa.

NEMATODES.

1. *Immature nematodes* (*Ascaris*). [Pl. XIV, figs. 168–171.]

Collected by Vinal N. Edwards, November, 1886. These were very numerous on the stomach and liver; slender, white, smooth, head truncate, tail ending with a mucronate spine. Another lot in U. S. National Museum collection, specimens somewhat larger, rudimentary lips of *Ascaris* discernible and tail not much prolonged beyond anal aperture; mucronate tip to tail not spine-like. These are probably an older stage of the same. The spine-like character of the mucronate tip apparently lost by the shedding of the embryonic investment. Dimensions in millimeters: Length, 21; diameter of head 0.25, middle 0.4, at anal aperture 0.09; distance of anal aperture from posterior end, 0.13. Corresponding dimensions of more mature specimens: 25; 0.24, 0.42, 0.16; 0.16.

CESTODES.

2. *Larval cestodes* (*Scolex polymorphus* Dujardin). In intestine. See **4**, p. 289, etc. Found July and Aug., 1899, Aug., 1900. Those obtained on the latter date were very small.

TREMATODES.

3. *Distomum vitellosum* Linton. Intestine. See **7**, p. 290, pl. XXXVII, figs. 38, 39. Found in this host July 28, 1899.
4. *Distomum pyriforme* Linton. Intestine. See **7**, p. 292, pl. XXXVIII, figs. 52–59. Found in this host in August, 1899 and 1900.
5. *Distomum* sp. Intestine. [Pl. XXVIII, fig. 311.]

Two distomes, found July 28, 1899. The following description is based on a memorandum sketch of the living worm and on a mounted specimen. Unfortunately one of the specimens was in bad condition when it was found. Body ovate-elliptical, depressed, with a short, retractile caudal appendix; neck short. Oral sucker subterminal with somewhat triangular aperture, a little broader than long. Pharynx subglobular immediately following the oral sucker. Œsophagus short. Intestinal rami simple elongate, extending to but not entering the appendix. Acetabulum at about the anterior fifth or sixth of the body, a little broader than long, in ventral view, much larger than oral sucker, aperture circular in life, transverse in alcoholic specimen. Cirrus pouch and seminal vescicle behind acetabulum; the cirrus passes to the left of the acetabulum and opens about half way between the suckers on the median line near the œsophagus. Testes two, large, subglobular, placed transversely behind the acetabulum, from which they are separated only by the cirrus pouch and seminal vescicle. Ovary globular, smaller than the testes on median line behind the testes and close to them. Vitelline glands, two slender, convoluted tubular organs marginal to right and left of ovary. No ova were seen in the living specimen and the uterus was not seen.

Dimensions of living specimen slightly compressed, measurements given in millimeters: Length, 3.07; diameter, anterior 0.54, at acetabulum 0.92, median 0.92, near posterior 0.50; oral sucker, length 0.24, breadth 0.24; acetabulum, length 0.41, breadth 0.43; diameter of testis, 0.46; pharynx, length 0.14, breadth 0.14; œsophagus, length 0.07, breadth 0.08.

Dimensions of specimen mounted in balsam, in millimeters: Length, not including appendix, 1.9; length of appendix, 0.32; breadth of body, anterior 0.16, median 0.77, posterior 0.29; of appendix 0.17; oral sucker, length 0.13, breadth 0.14 (in the other (damaged) specimen these dimensions are 0.17 and 0.20); acetabulum, length 0.32, breadth 0.34 (0.45 and 0.41 in the other); pharynx, length 0.08, breadth 0.09 (0.09 and 0.15 in the other).

In the mounted specimen what I take to be an ovum lying dorsal to one of the testes is 0.035 and 0.021 mm. in the two principal diameters.

Tautogolabrus adspersus, *Cunner, Chogset.*

FOOD.

Seaweed, hydroid stems, bryozoa, tunicates, annelids, small crustaceans of various kinds (*Caprella*, shrimps, etc.), univalve mollusks found in stomach and intestine—in short, just such food as the fish would get by browsing on the material which grows on wharf piles and similar places.

NEMATODES.

1. *Immature nematodes.* On viscera. Aug. 12, 1900.

CESTODES.

2. *Rhynchobothrium.* Cysts on viscera. **7**, p. 281. Aug. 29, 1899; July 27, 1900.

TREMATODES.

3. *Immature distomes encysted in skin.* **7**, pp. 281, 298, pl. XL, figs. 76–81. Seen frequently in 1899 and 1900. Dr. G. H. Parker reports that a large proportion, out of about 100 cunners collected this summer, are infested with this parasite.
4. *Distomum areolatum* Rudolphi. Intestine. See **7**, pp. 293–294, pl. XXXIX, figs. 60, 63. Found in this host Aug. 5, 1899.
5. *Distomum vitellosum* Linton. Intestine. See **7**, p. 290, pl. XXXVI, figs. 38, 39. Found in this host Aug. 5, 1899.

Tautoga onitis, *Tautog, Black-fish.*

FOOD.

In specimens examined previous to 1899 the stomachs were empty. In the summers of 1899 and 1900, 24 tautog were examined. In the alimentary canals of the large specimens a great variety of crabs and mollusks were found. A specimen taken at Menemsha Bight, August 1, 1899, had its alimentary canal filled with fragments of crabs and mollusk shells. Among them were recognized *Trittia trivitata* (many), *Purpura lapillus, Lunatia heros, Acmæa testudinalis, Mytilus edulis* (many fragments), *Cancer irroratus, Eupagurus pollicaris* (many), *Libinia canaliculata.* The shells and tests had all been more or less crushed and broken. No entozoa were found in the alimentary tract of this fish. Indeed, it is difficult to see how any could stay in a fish which lives on such a mechanically anti-helminthic diet. In small specimens were found seaweeds, a variety of small crustacea (amphipods, copepods, shrimps, small crabs, etc.), mollusks, both univalve and bivalve, and annelids.

TREMATODES.

1. *Immature distomes encysted in the skin.*

The entire surface of specimen from Menemsha, mentioned in the food notes given above, was thickly peppered with small black pigment patches, in which small cysts could be seen. These pigment patches and cysts have a general resemblance to those described from the cunner. [**7**, pp. 281, 296, pl. XL, figs. 76–81.] These cysts were so abundant in this specimen that it was a difficult matter to find a scale which was free from them. Usually there was a cluster, often containing as many as 6 or 8 cysts, on each scale. The fins were also thickly beset with them. Even the corneas of the eyes were infested with them; 74 were counted on one eye and 81 on the other; 14 and 17, respectively, were over the pupils. [Pl. XXVIII, fig. 318.] The walls of the cysts were transparent, so that the suckers of the contained distome could be distinguished through them.

Chætodipterus faber, *Moon-fish.*

This fish is rarely taken in the vicinity of Woods Hole. In October, 1886, I received from Mr. S. E. Meek, Fulton Market, New York, a few cysts from the abdominal cavity of a moon-fish from the North Carolina coast, from which the following were obtained.

NEMATODES.

1. *Ichthyonema* sp. From abdominal cavity. [Pl. XVIII, figs. 218, 219.]

The longest entire specimen measured 217 mm. in length; of nearly uniform diameter throughout, maximum diameter 1.6 mm., diameter near anterior end 0.4 mm., increasing soon to 1 mm. In another, a fragment, whose maximum diameter was 1.12 mm., the diameter of the head was 0.23 mm. It was surmounted by four distinct papillæ. The uterus contained ova in various stages of segmentation along with embryos which agree with those described under *Ichthyonema globiceps.* Length, 0.5 mm.; greatest diameter, 0.013 mm. Exceedingly fine-pointed at smaller end. In the larger specimen the principal part of the body, more particularly the anterior half, was literally packed with young.

CESTODES.

2. *Rhynchobothrium speciosum* Linton. Cysts on viscera. **4**, pp. 801–805, pl. LXIV, figs. 13, 14, and pl. LXV, figs. 1–7.
3. *Tetrarhynchus.* Cysts on viscera. **4**, p. 808.

Balistes vetula, *Trigger-fish.*

FOOD.

Twelve small specimens from Katama Bay were examined September 1, 1899. Amphipods, copepods, and seaweed were found in the alimentary canal, but no entozoa.

Alutera schœpfii, *File-fish.*

FOOD.

The stomachs have usually been empty. Two were seen, however, one on July 24, 1887, the other August 5, 1889, in which there were stems of hydroids. In one of these the intestine was filled throughout its length with masses of hydroid stems.

CESTODES.

1. *Dibothrium aluteræ.* Intestine. **1**, pp. 458–459, pl. I, figs. 5–8.
2. *Rhynchobothrium bulbifer* Linton. Cysts on viscera. **4**, p. 793.
3. *Rhynchobothrium.* Cysts in coats of stomach and intestines. **4**, p. 798.

TREMATODES.

4. *Distomum pallens* Rudolphi. Intestine. **6**, pp. 526–527, pl. XLVII, figs. 8, 9.
5. *Distomum valdeinflatum* Stossich. Capsules on peritoneum. **6**, pp. 527–528, pl. XLVII, figs. 10–14, and pl. XLVIII, figs. 1, 2.

Lagocephalus lævigatus, *Smooth Puffer.*

One specimen from Narragansett Bay, July 22, 1887.

NEMATODES.

1. *Immature nematode* (*Ascaris*). [Pl. XI, figs. 121, 122.] From intestine. Dimensions in millimeters: Length, 22; diameter of head 0.1, 1 mm. back of head 0.28, maximum a short distance back of middle 0.48, 1 mm. from posterior end 0.32, at anal aperture 0.12; distance of anus from posterior tip, 0.13; œsophagus short.

CESTODES.

2. *Scolex polymorphus* Dujardin. Abundant, in intestine.

TREMATODES.

3. *Distomum* sp. Intestine. **6**, pp. 537–538, pl. LIII, figs. 1, 2. This specimen bears a close resemblance to *Distomum* sp. from the scup. See No. 11 under *Stenotomus chrysops.*

Spheroides maculatus, *Puffer.*

FOOD.

This species was examined on three occasions in 1899. August 5; 9 small; alimentary canal contained small crabs, amphipods and both lamellibranch and univalve mollusks. August 28; 3 small; hermit crabs and crepidulæ in alimentary canal. August 30; 12 small; crustaceans, small lamellibranch shells, annelids, seaweeds, and sand in alimentary canal. August 28, 1900; 3 small specimens from Katama Bay; shrimps and other small crustaceans in alimentary tract.

ACANTHOCEPHALA.

1. *Echinorhynchus acus* Rudolphi. Pharynx. **7**, p. 281.

CESTODES.

2. *Tetrarhynchus* sp. Cyst, pharynx. **7**, p. 281.
3. *Larval cestodes* (*Scolex polymorphus* Dujardin). Free in intestine. See **4**, pp. 789–792, pl. LXI, figs. 4–15. Aug. 5, 1899; 28.

TREMATODES.

4. *Distomum vibex* Linton. Intestine and pharynx. **7**, pp. 281, 291–292, pl. XXXVIII, figs. 48–51. Some small distomes found by Dr. F. P. Gorham in young puffers seem to be the young of this species.
5. *Distomum vitellosum* Linton. Intestine. Aug. 28, 1899. See **7**, p. 290.
6. *Distomum* sp. In cyst, on viscera. This distome was about 0.7 mm. in length and spinose. Probably *D. valdeinflatum.* August 5, 1899.

Chilomycterus schœpfi (*C. geometricus, Diodon maculo-striatus*), *Puffer, Porcupine-fish.*

NEMATODES.

1. *Ascaris neglecta* Leidy. [Pl. v, figs. 33–36.]

Two specimens from intestine of this fish July 21, 1887, are referred to this species; one male and one female, the latter with the anterior end missing. Leidy's description of this species is: "Body cylindro-fusiform, most narrowed anteriorly; head naked; lips large and obtuse; tail short, conical, acute. Length of female 2 inches, breadth three-fifths of a line; male about half the size." In these specimens the body is transversely wrinkled, producing a beautifully crenulated margin, the crenulations themselves being made finely dentate by transverse lines. Tail mucronate, the tip slightly roughened. No postanal papillæ were made out. There are twenty preanal papillæ, more or less, on each side arranged in a single row; those immediately preceding the anal aperture are the smaller. The papillæ suggest *A. habena*. The length of the fragment of a female was 15 mm., and its diameter 1.3 mm. It exhibited the same crenulate margin with dentate detail of outline as the male.

Dimensions of male in millimeters: Length, 26; diameter of head 0.17, 1 mm. from anterior end 0.21; maximum diameter, near posterior end 0.8, 1 mm. from posterior end 0.62, at anal aperture 0.15; length of head 0.15; distance of anal aperture from posterior end 0.13; length of œsophagus 6.3; length of copulatory spines 4.25, breadth 0.02.

CESTODES.

2. *Ligula chilomycteri.* **4**, pp. 788–789, pl. LXI, fig. 1.

Mola mola (*Mola rotunda*), *Sun-fish.*

FOOD.

I add the following to the meager food notes made in my report for 1898 [**7**, p. 281]: July 19, 1899; 1. Stomach and intestine filled with chyle resembling thick soup or gravy, with remains of salpæ and possibly ctenophores. July 30; 1. The alimentary canal, which in this singular fish is little differentiated into stomach and intestine, and in this individual measured 3.7 meters (12⅓ feet), contained a thickish soup or gravy-like chyle, which in places was held together by a viscid mucus. A large number of salpæ and numerous small, pinkish amphipods were found, the latter more abundant toward the lower part of the intestine. July 10, 1900; 1 (weight, 286 pounds). The alimentary canal contained a yellowish-gray soup-like chyle. Food material not distinguishable. July 29; 1. Taken by the schooner *Grampus* south of Gay Head. A large jelly-fish is reported by Mr. C. W. Stone from the stomach.

ACANTHOCEPHALA.

1. *Echinorhynchus acus* Rudolphi.

A fragment found with a lot of trematodes from the gills, collected by Vinal N. Edwards, July 13, 1881, appears to belong to this species.

NEMATODES.

2. *Immature nematode.* [Pl. vi, figs. 51, 52.]

A small specimen was found encapsuled on the intestine, July 10, 1900.

CESTODES.

3. *Dibothrium microcephalum* Rudolphi. Intestine. **2**, pp. 736–745, pl. II, figs. 5–18. **7**, p. 282.

Thirty-three specimens were obtained July 30, 1899. Twenty of these were normal. In the others the first, and sometimes the second joint also, was elongated and slender. [Pl. xxv, figs. 270, 271.] A similar condition was noted in **2**, pp. 736–737. Thirty-three, also obtained on July 10, 1900, longest 150 cm.; total length of worms about 30 meters (100 feet). July 29, 1900; numerous. Mr. C. W. Stone reports that the harpoon passed through the intestine, and that the tapeworms were in consequence much broken. Only a few were preserved. The largest fragment, which consists of mature proglottides throughout, measures 86 cm. in length and 10 mm. in breadth at widest part. It is 7 mm. wide at anterior end and of nearly uniform breadth, narrowing, however, at posterior end. Another fragment, with scolex attached, which may be a part of the same worm, is 17 cm. in length.

4. *Tetrarhynchus elongatus* Wagener. Liver. **4**, pp. 812–813, pl. LXVII, figs. 9–12. **7**, p. 282. July 19, 1899; 5 scolices. July 10, 1900; 6 scolices. July 30, 1899; several. July 29, 1900; several.

One of these larvæ in its blastocyst was dissected out of the liver by Mr. W. W. Francis, July 19, 1899. Its dimensions, in millimeters, follow: Length of anterior actively motile part of blastocyst 18, diameter 4; length of posterior part of blastocyst 400, diameter 2. These dimensions were changed somewhat after the specimen had been lying in water for three or four hours. After killing, the length of the anterior portion was 24 mm. and of the posterior 440 mm., the diameter remaining the same as in the living specimen. The posterior two-thirds was embedded in the liver; the anterior third was on the surface, but under the serous coat. In another specimen the anterior part was 40 mm. in length. The posterior portion was not all dissected out. If the proportions are the same as in the first, it should be 800 mm. in length. The five specimens represent an aggregate length of probably 3 meters, 2 of which are in the substance of the liver. The explanation of the great length which these cestodes attain in the liver of the sun-fish is doubtless to be found in the fact that the life of the host is very long, and therefore the time which the worm is doomed to remain in the liver after it has once gained a lodgment there must likewise be very long. Of course its surroundings must be congenial and conducive to longevity, else its tissues would, sooner or later, degenerate. Although this cestode appears to be invariably present in the liver of the sun-fish, it may be questioned whether the sun-fish is, in a strict sense, the proper intermediate host of this worm. It would indeed be a large animal, and one with phenomenal digestive powers, which would habitually use the sun-fish for food.

5. *Rhynchobothrium* sp. From cysts on intestine under the serous coat. July 7, 1900. [Pl. XXII, figs. 245–250.]

Length of cyst, 27 mm.; breadth, 16 mm. A globular portion of the cyst was of dense connective tissue 5 mm. thick; the space within, about 2 mm. in diameter, was filled with yellowish coagulated fluid. The blastocyst, which had evidently at one time occupied this space but now lay in a thinner walled part of the cyst, was 42 mm. in length and 5 mm. in greatest diameter. It contained a larval *Rhynchobothrium* which, when everted, measured 20 mm. in length.

TREMATODES.

6. *Tristomum molæ* Blanchard. [*Tristomum rudolphianum* Diesing.] Skin, gills. **6**, p. 510. **7**, p. 281.

A sun-fish captured July 30, 1899, was reported by Dr. Dahlgren to have had 138 trematodes on the skin. July 19, 1899; 1. This was translucent, bluish-white, with a shade of pink, especially toward the posterior end. Lateral areas, dark-brown. July 10, 1900; 2.

7. *Distomum macrocotyle* Diesing. Intestine. **6**, pp. 522–523, pl. XLV, figs. 9, 10, and pl. XLVI, figs. 1–5. **7**, p. 282. July 29, 1900; 12.
8. *Distomum contortum* Rudolphi. Intestine. **6**, pp. 528–530, pl. XLVIII, figs. 3–7. July 19, 1899; 3.
9. *Distomum nigroflavum* Rudolphi. Intestine. **6**, pp. 530–531, pl. XLVIII, figs. 8–11, and pl. XLIX, figs. 1, 2. **7**, p. 282. July 30, 1899; 9. July 10, 1900; 2. July 29, 1900; 3.
10. *Distomum foliatum* Linton. Intestine. **6**, pp. 532–534, pl. XLIX, figs. 3–5; pl. L, figs. 1–3; pl. LI, figs. 1–4. **7**, p. 282. July 19, 1899; 1. July 10, 1900; 4. July 29, 1900; 1.
11. *Distomum fragile* Linton. Intestine. **6**, pp. 282–295, pl. XXXIV, figs. 68–70. July 10, 1900; numerous. Length of living specimens, 4.2 mm.

Many copepod parasites were seen on the sun-fish; numerous flat, scale-like forms on the skin; large paired forms on the gills and long lerneans with heads buried in the flesh, the body with eggs hanging like a dark-brown tassel from the skin. One parasitic copepod was found under the skin, which at that point was over an inch thick.

Myxocephalus æneus (*Cottus æneus, Acanthocottus æneus*), *Little Sculpin, Grubby.*

FOOD.

Annelids, copepods, shrimps, and young fish found in the alimentary canals of young specimens. Many young flounders and shrimps taken from alimentary tracts of young sculpin from Katama Bay, August 28, 1900.

ACANTHOCEPHALA.

1. *Echinorhynchus acus* Rudolphi. **3**, p. 525.

NEMATODES.

2. *Immature nematodes* (*Ascaris*). **7**, p. 282.

Two lots of these specimens, collected by Vinal N. Edwards November 5, 1886, and October 24, 1887, are in the U. S. National Museum collection. They are of nearly uniform diameter, but taper a little more anteriorly than posteriorly; the largest are 22 mm. in length and 0.5 mm. in greatest diameter. They agree with immature ascarids from *Prionotus carolinus.*

2*a*. *Ascaris* sp. [Pl. VIII, figs. 70–72.]

Specimen, a female, collected by S. E. Meek, Fulton Market, New York, October 28, 1886. Dimensions in millimeters: Length, 50; diameter, head 0.26, maximum (posterior third) 1.75, 1 mm. from head 0.26, 1 mm. from posterior end 0.9, at anal aperture 0.32; distance of anal aperture from posterior end, 0.4.

CESTODES.

3. *A larval cestode*, probably *Dibothrium* sp. On viscera.

Small, somewhat flask-shape, with pore at anterior end. July 27, 1900.

4. *Rhynchobothrium* sp. Cysts in muscles. **4**, p. 798.

TREMATODES.

5. *Distomum appendiculatum* Rudolphi. Intestine. July 27, 1900. See **7**, p. 289, pl. XXXVI, figs. 25, 26.

Dimensions in millimeters (alcoholic specimens): Length, 2.10; diameter oral sucker 0.065, of acetabulum 0.148; ova, 0.024 and 0.010 in the principal diameters.

Cottunculus thomsonii.

NEMATODES.

1. *Ascaris* sp. [Pl. IX, figs. 84–87.]

Fourteen specimens from stomach of fish taken by steamer *Albatross*, station 2739, 1887; depth, 811 fathoms. Body thickened posteriorly, attenuate anteriorly, most rapidly for first 5 mm., crossed by minute transverse striæ, which are 0.025 mm. apart. Length of lips about equaling diameter of head; lateral lips each with a single papilla near front edge; anterolateral edges prominent and rounded; lateral membrane of lip narrow; triangular interlip large; lips unsymmetrical. Posterior end of body curved in males, straight in females. The largest specimen measured 97 mm. in length and 1.5 mm. in diameter. Dimensions of another specimen, a female, in millimeters: Length, 84; diameter of head 0.2, near middle 1.25, 10 mm. from posterior end 1.3, at anal aperture 0.5; length of lips, 0.2; distance of anal aperture from posterior end, 0.8 The larger males nearly equal the larger females. Two postanal papillæ were made out in side view of larger specimens. In a smaller specimen, 28 mm. in length, 3 postanal on each side and 17 preanal on one side and 19 on the other were seen. These were arranged in a single row on each side. Spines slender and sharp-pointed; length, 2 mm.; diameter, 0.02 mm.

Hemitripterus americanus, *Sea Raven, Red Sculpin.*

NEMATODES.

1. *Ascaris* sp. [Pl. IX, figs. 91–94, and pl. XIII, figs. 157–159.]

U. S. National Museum collection; collected by Vinal N. Edwards, November 5, 1886. These worms are of nearly uniform diameter throughout, a little thickened posteriorly, the tail recurved. Narrow alæ were observed near the head of one, a female; body smooth. A male, 40 mm. in length, diameter of head 0.23 mm. and of body 0.7 mm., and length of spines about 0.3 mm., had about twenty preanal papillæ on one side. These appeared to lie in a single row, the posterior ones being close together and small, the anterior ones more sparsely distributed and larger; postanal region short.

Another lot, collected also by Mr. Edwards, October 12, 1887, appear to be immature females of the same species. The embryonic cuticle was still adherent to the posterior end of one. The alæ back of the head were more distinct and the postanal region rather more elongated. Dimensions in millimeters: Length, 20; diameter of head 0.25, middle 0.6, at anal aperture 0.23; distance anal aperture from posterior tip, 0.34.

Several other lots, most of them collected by Mr. Edwards, consist of immature nematodes encapsuled on viscera. They are young ascarids, and while their relative proportions differ considerably from the larger specimens they are, without much doubt, younger forms of the same species. Dimensions of a typical specimen in millimeters: Length, 15; diameter of head 0.08, middle 0.31, at anal aperture 0.12; distance of anal aperture from posterior tip, 0.21. [Figs. 157–159.] See under *Glyptocephalus cynoglossus.*

TREMATODES.

2. *Distomum simplex* (?) Rudolphi. Intestine. **6,** pp. 525–526, pl. XLVII, figs. 3–7.

Opsanus tau (*Batrachus tau*), *Toad-fish.*

FOOD.

Among my food notes of this species I find the following noted: *Littorina littoria, Ilyanassa obsoleta, Trittia trivitata, Urosalpynx cinerea,* usually with hermit crabs; *Crepidula fornicata, Pecten irradians, Cancer irroratus, Palæmonetes vulgaris, Eupagurus longicarpus;* bones and other fragments of fish; a partly digested toad-fish. I have seen a toad-fish in the aquarium in the act of swallowing another of its own species but little smaller than itself. In the alimentary canal of a small specimen two shells of *Utriculus canaliculatus* (Bulla) were found.

ACANTHOCEPHALA.

1. *Echinorhynchus acus* Rudolphi. Intestine. Oct. 22, 1887. Collected by Vinal N. Edwards. Length, 22 mm. See **3,** p. 525; **1,** p. 492.
2. *Echinorhynchus agilis* Rudolphi.

   In the U. S. Nat. Mus. collection; a single specimen, collected at Woods Hole. Length, 4 mm.
3. *Echinorhynchus fusiformis* Zeder (?). [Pl. II, fig. 11.] Intestine.

One specimen, a male, collected August 7, 1899. This appears to be near *E. fusiformis* Zeder. The body is fusiform, gradually attenuate in front to the base of the proboscis, abruptly constricted at testes, whence it is cylindrical to the posterior end. Proboscis clavate; eight vertical rows of hooks visible on a side and about fifteen hooks in a vertical row. The hooks are sharp, recurved, and rather slender. Testes two, elongated, lying end to end, and are followed by an elongated, tubular, seminal receptacle and a subglobular bulbus ejaculatorius (?), which communicates with the copulatory bursa by a slender duct.

Dimensions of a mounted specimen, from which this description was written, in millimeters: Length, 5; length of proboscis 0.66, of proboscis sheath 0.73, of lemnisci 1; diameter of proboscis, apex 0.15, middle 0.13, base 0.10; diameter of body anterior 0.15, middle 0.48, posterior 0.13.

NEMATODES.

4. *Ascaris habena* Linton. Stomach and intestine. **7,** pp. 282, 302–303, pl. XLIII, figs. 109–115.

Found five times in the summer of 1899 and four times in the summer of 1900. It was found in every lot of toad-fish examined, although not in every individual. The eggs of this species are large and rather transparent. [Pl. VI, figs. 56 *a–i.*] The number of chromosomes appears to be small. A sketch of a young specimen with embryonic cuticle is shown in pl. VI, fig. 55.

CESTODES.

5. *Rhynchobothrium tumidulum* Linton. Scolices in intestine. See **2,** pp. 829–832, pl. XI, figs. 3–11. July 26, 1900; 1. Aug. 10, 1900; numerous.

These scolices are characterized by having a conspicuous red pigment blotch in the neck. Others with essentially the same kind of proboscides, but with no red pigment, were found August 5, 1899. The hooks and proboscides resemble *R. tumidulum.* [Pl. XXI, fig. 241.]

TREMATODES.

6. *Distomum tenue* Linton. Intestine. See **6,** pp. 535–536, pl. LII, 2–8. Aug. 15, 1899; July 26, 1900; Aug. 4 and 10, 1900; few. Color in life translucent bluish-white, vitellaria yellowish-green.

A small globular cyst, yellowish, in one lot, from the viscera and several others from cysts in the liver in another lot contained minute distomes, which are probably young of this species. There was a double row of spines around the mouth, about 25 in each row.

7. *Distomes* (undetermined species). [Pl. XXIX, figs. 324–329.] Intestine.

On August 15, 1899, a small lot of distomes were obtained in which there are at least two distinct species. On account of the small number and the unsatisfactory condition of the preserved material I shall not assign specific names to them. They were associated with specimens of *D. tenue* and *D. tornatum*.

A. (Figs. 324, 326.) One larger and one smaller specimen. The living worms were yellowish. Body oblong, appressed, transversely rugose, with minute scattering scale-like spines (easily overlooked). Oral sucker and acetabulum about equal. Aperture of mouth in smaller specimen with notch at anterior border (not noted in larger specimen); aperture of acetabulum a little wider than long. Pharynx longer than broad, apparently protruding into the oral sucker. Œsophagus, if any, short; intestinal rami simple, extending nearly to the posterior end. Testes two on median line about middle of body, the anterior testis subglobular, the posterior somewhat three-lobed. Seminal vesicle (made out only in smaller specimen) dorsal to acetabulum; genital aperture on median line immediately in front of acetabulum; ovary near posterior border of acetabulum, a little to left of median line; a seminal receptacle was made out in the smaller specimen anterior to the ovary, and to the left; vitellaria voluminous in posterior and lateral regions of body and extending at least as far forward as the acetabulum, in the smaller specimen as far as the pharynx. Ovum, in larger specimen only, 0.10 and 0.07 in the two principal diameters.

The following table shows the dimensions in millimeters, the larger specimen in turpentine, the smaller in balsam:

	Larger specimen.	Smaller specimen.
	mm.	*mm.*
Length	3.60	1.10
Greatest diameter	.80	.37
Length of anterior sucker	.36	.17
Breadth of anterior sucker	.38	.18
Length of acetabulum	.38	.17
Breadth of acetabulum	.42	.21
Length of pharynx	....	.08
Breadth of pharynx	....	.11

B. Two specimens stained and mounted in balsam. These agree in the relative proportions of suckers and pharynx, in the position of the genital aperture, and the general arrangement of testes and ovary. The greatest difference is in the character of the vitellaria; other differences may be accounted for by different conditions of contraction.

Characters common to both are: Acetabulum much larger than oral sucker, broader than long; oral sucker longer than broad; pharynx nearly as large as oral sucker; œsophagus short; intestinal rami simple, reaching nearly to posterior end; testes two on median line in about the posterior third of body, the anterior testis immediately preceded by the ovary, which lies a little to the right of the median line; genital aperture a short distance in front of acetabulum, to the left of the median line; the radiating muscles of the cirrus bulb are distinctly seen in ventral view upon focusing with a high power.

a. (Fig. 327.) This specimen was probably killed while flattened out under pressure. The body is smooth, the intestinal rami thin-walled and inflated. There is a vitelline reservoir immediately in front of the ovary, into which two anterior and two posterior vitelline ducts empty. The vitellaria are rather irregular small granular masses at the posterior end of the body and along the lateral margins nearly to the acetabulum. The two testes and ovary are each subglobular.

b. (Figs. 328, 329.) This specimen is much contracted. The body is transversely rugose, and the posterior region, when strongly magnified, is seen to be beset with minute, bristle-like spines. The intestinal rami are slender, but thick-walled. The vitellaria are at the posterior end of the body and along the margins as far forward as the pharynx; the granular masses larger and more crowded than in *a*. Testes and ovary broader than long.

Dimensions in millimeters:

	a.	b.
	mm.	mm
Length	1.21	0.88
Maximum diameter	.43	.45
Length of oral sucker	.16	.16
Breadth of oral sucker	.11	.13
Length of acetabulum	.17	.20
Breadth of acetabulum	.23	.28
Length of pharynx	.11	.17
Breadth of pharynx	.10	.11
Longer diameter of ovum		.045
Shorter diameter of ovum		.024

8. *Monostomum vinal-edwardsii* sp. nov. [Pl. XXXIV, figs. 373–376.] Aug. 5, 1899; 7. July 26, 1900; Aug. 4 and 10, 1900; numerous. Young and adult together in same lot.

The following preliminary synopsis of these interesting trematodes is here given: Body thickish, depressed, slightly convex above, flat below, outline varying but approximating ovate, covered with exceedingly minute villous spines. Oral sucker circular, subterminal, aperture nearly circular. Pharynx varying in preserved specimens, subglobular in life near oral sucker, but in favorable positions seem to be separated by a short canal. Œsophagus short; intestinal rami two, simple, extending to posterior end of body. Testes in the larger specimens apparently eight, four on each posterolateral margin (in one specimen there were five on the right side and four on the left). In smaller specimens the testes are in two lateral clusters of four or five or more testicules each, situated at about the posterior third, which in such specimens is usually the widest part of the body. Seminal vesicle on median line, curving to the left, the cirrus opening by an acetabuliform aperture about the anterior third. The vitellaria are dendritic organs, distributed generally in the posterior part of the body behind the genital acetabulum in younger specimens, confined to the lateral regions of the middle third of the body of older specimens. Ovary a many-lobed organ on the median line a short distance behind the genital acetabulum, from which it is separated by the seminal receptacle and base of the cirrus pouch. Excretory vessels very numerous in the anterior third of the body, each opening independently on the surface. Uterus very voluminous, in the older specimens filling up all the posteromedian part of the body. Ova rather small and elliptical. Dimensions of a living specimen slightly compressed, in millimeters: Length, 2.36; diameter of oral sucker 0.25, of pharynx 0.15, of genital acetabulum 0.13; ova, 0.021 and 0.010 in the two principal diameters. At certain ages there is a very characteristic coloration in these worms, due to the different ages of the ova. The beginning folds of the uterus on the left side are opaque white; the next, toward the posterior and on the right side, are light yellow, shading into amber and smoky brown, becoming much darker toward the anterior.

The external opening of the uterus was not made out, although a minute aperture was noted in one specimen which had lain over night in salt solution 0.07 mm. in front of the genital acetabulum. This point will doubtless be settled when the specimens are sectioned.

Prionotus carolinus, *Sea Robin.*

FOOD.

Stomachs and intestines of this species have yielded a variety of material. In one specimen were found a young herring, several young clams (*Mya*), two shrimp (*Palæmonetes*), and a pebble. Small specimens have yielded shrimps in large numbers, amphipods and other small crustaceans, squid and lamellibranch mollusks, annelids, and seaweed. One small specimen had four young winter flounders in its stomach

NEMATODES.

1. *Immature nematodes.* On serous covering of viscera. Aug. 21, 1899; Aug. 21, 1900; few.

Some immature ascarids collected July 21, 1887, encapsuled in peritoneum. Dimensions in millimeters: Length, 20; diameter of head 0.11, 1 mm. from anterior 0.27, maximum 0.56, 1 mm. from

posterior end 0.35, at anal aperture 0.13; distance of anal aperture to posterior end, 0.25. Intestinal diverticulum noted at base of œsophagus in smaller specimens.

CESTODES.

2. *Rhynchobothrium.* Encysted on viscera. **4**, p. 795, pl. LXIII, figs. 3–5. **7**, p. 282.
3. *Tetrarhynchus bisulcatus* Linton. Encysted in stomach and intestine. **7**, p. 282.

TREMATODES.

4. *Distomum appendiculatum* Rudolphi. Intestine. See **7**, p. 289, pl. XXXVI, figs. 25, 26. Found in this host Aug. 5, 1899, and Aug. 10, 1900.
5. *Distomum* sp. Intestine. **7**, p. 295, pl. XXXIX, fig. 71. Probably the species called by me *D. vitellosum*. See under *Clupea harengus*, *Stenotomus chrysops*, etc.
6. *Diplostomum* sp. Intestine. One small specimen found Aug. 30, 1899.

Lopholatilus chamæleonticeps, *Tile-fish.*

FOOD.

Viscera of a number of tile-fish taken July 29, 1899, and placed in formalin were looked over and the following food notes made: Crabs in large numbers, the intestines of some of the fish being filled with them. A part of a squid was found in one, and in the stomach of another were two spiny dog-fish (*Squalus acanthias*). In others, taken August 10, 1899, 80 miles south of Gay Head, were found many crabs, a bivalve mollusk (*Yoldia*), tests of large salpa, an eel, and bones of fish. The following list was made out from the contents of the alimentary canals of 18 specimens taken July 30, 1900, south of Marthas Vineyard in 65 to 110 fathoms: Pieces of menhaden (bait) in stomachs of three or four; intestines, particularly the lower parts, filled with fragments of crustaceans, in which a few mollusk shells, salpæ, annelids, a holothurian, actinians, and fish bones were found.

For assistance in the following partial identification of this material I am indebted to Mr. Freeland Howe: *Munidia caribæa* (very abundant), eupagurids (abundant), brachyurans (abundant), spider crabs, small (many), *Nepturus*, *Yoldia* (few), *Cardium?* (fragment of valve), nereis-like annelid (one and fragment), sandy worm-tube (one), *Adamsia sociabilis* (abundant), *Thyone* sp. (one, identified by Dr. H. C. Clark), tunics of *Salpa zonaria-cordiformis* (numerous), fish bones (otic bones, vertebræ, lenses, etc., numerous).

The tile-fish is preeminently a crab-eater. On account of the nature of its diet, which must be a very trying one on any entozoan which attempts to maintain a position in the alimentary tract, not many entozoa are to be expected in the tile-fish, and few are found.

ACANTHOCEPHALA.

1. *Echinorhynchus.* Representatives of this genus found on two occasions.

a. July 29, 1899. An immature specimen from a cyst in the stomach wall. [Pl. II, figs. 6, 7.] Only the anterior end could be found when the specimen was mounted. The proboscis is only partly everted and its basal portion is retracted for a short distance by the inversion of the anterior end of the body; so far as it can be seen, the proboscis is clavate, though it is probably fusiform when fully everted. The hooks are prominent; those in about the first four basal rows are arcuate, slender, others recurved, all rather large; sheath thickest in middle, tapering toward its posterior end; lemnisci slender, a little longer than sheath. Dimensions of specimen mounted in balsam, in millimeters: Diameter of base of proboscis (a part of the base is concealed), exclusive of hooks 0.33, including hooks 0.44; diameter of apex of part extended, excluding hooks 0.36, including hooks 0.5; length of part of proboscis everted, 0.36; length of entire proboscis (estimated), 0.857; length of longest hooks, 0.09; length of sheath, 0.87; diameter of sheath, anterior 0.36, middle 0.4, posterior 0.26; lemnisci extend about 0.07 beyond sheath and are about 0.045 in diameter.

b. July 30, 1900. [Pl. II, figs. 8–10.] A small female from the intestine. Body nearly linear, tapering very gradually toward the bluntly rounded posterior end. Proboscis erect, cylindrical, with numerous hooks placed very close together so that point of one hook overlaps the base of the succeeding hook. Hooks in one or two of the basal circles slender and arcuate, others stout and abruptly recurved;

about 14 rows of hooks visible counted transversely, and about 16 counted from base to apex. The sheath is cylindrical and the lemnisci appear to be a little shorter than the sheath. Dimensions of alcoholic specimen, in millimeters: Length, 10; length of proboscis, 0.72; diameter of proboscis, base 0.34, middle 0.33, apex 0.28; length of longest hooks, 0.06; length of sheath, 1.16; diameter of sheath, 0.32; diameter of body, anterior 0.58, near posterior 0.43.

NEMATODES.

2. *Immature nematodes.* [Pl. XI, figs. 123, 124.] Encapsuled and free.

Found on each occasion on which this fish was examined. On July 30, 1900, rather numerous. The worms were still living when they were examined and appeared to be identical with immature nematodes from *Urophycis chuss* and *Paralichthys oblongus*, with which they were compared. Figs. 123 and 124 are from sketches of a specimen collected by the Fish Commission in 1881. Length, 15 mm.

CESTODES.

3. *Larval cestodes* (*Scolex polymorphus* Dujardin). Free in intestine. See **4**, p. 789, etc.

Noticed in material collected August 10, 1899; rather numerous in material collected July 30, 1900. The latter were still active, the viscera from which they were obtained having been kept on ice for two days. They appear to be similar to forms found in the squeteague and other fish, although doubtless many species are represented by this well-named *Scolex polymorphus*. Red pigment patches were noted in the necks of these larvæ.

4. *Tænia-like fragments.* Intestine. **7**, p. 282.

5. *Cestode;* new. Intestine. [Pl. XX, figs. 233, 234, and pl. XXI, figs. 236–238.]

Two scolices, which appear to belong to an undescribed genus, were obtained from the intestine of a tile-fish July 29, 1899. The specimens had been in formalin for two days before I had an opportunity of seeing them. The heads and posterior parts were white, the neck and median parts pinkish. They were about 6 mm. and 8 mm. long, respectively. The scolex resembles *Echeneibothrium* in having four unarmed bothria and a terminal muscular disk which is provided with an anterior central auxiliary sucker. Each bothrium, considered alone, suggests the genus *Phyllobothrium*, being without transverse costæ, having the borders thrown into crumpled folds and being provided with an auxiliary acetabulum on its anterior border. The bothria seem to be placed on the head, as in *Crossobothrium*, while they project in the preserved specimens so as to stand nearly perpendicular to the flat surface of the neck, as in *Calyptrobothrium*. The muscular disk in front of the bothria suggests the genera *Tylocephalum* and *Discocephalum*, while the terminal auxiliary acetabulum, which can be seen in the mounted specimen and has its presence fully demonstrated in longitudinal sections, finds its counterpart in the genus *Echeneibothrium*. The auxiliary acetabula on the bothria are concealed by the anterior muscular disk and are difficult to see in these specimens. Transverse sections of the body show no rudiment of reproductive organs, no differentiation of a central core, only a few comparatively coarse longitudinal muscles in the parenchyma.

The vessels of the water-vascular system are prominent and tortuous, and may be seen along the lateral margins of the body, the margins of the bothria, and extending into the muscular disk. Other dimensions in millimeters are: Breadth of disk between bothria 1.16, thickness 0.93; thickness of head through bothria, 1.31; transverse diameter of head, 1.74; diameter of anterior acetabulum, 0.15; breadth of body back of head 1.09, thickness 0.6.

6. *Tetrarhynchus bisulcatus* Linton. Scolex. July 30, 1900.

This specimen agrees with *T. bisulcatus*, except that the collar is wider than the head, and rugose.

TREMATODES.

7. *Distomum ocreatum* Molin. Intestine.

Twelve specimens obtained August 10, 1899, agree with the species which I have been recording under this name. Length of specimens mounted in balsam vary from 1 mm. to 2.5 mm. See **6**, pp. 514–515, pl. XLII, fig 13. **7**, p. 288, pl. XXXV, figs. 16–24.

8. *Distomum fœcundum* Linton. Intestine. **7**, pp. 282, 289–290, pl. XXXVI, figs. 27–35, and pl. XXXVII, figs. 36, 37.

July 30, 1900; 1, which is probably to be referred to this species. The material from the intestine was washed out in fresh water. Some distomes swell up when placed in fresh water, the acetabulum

becomes prominent, and the general appearance becomes much altered. While this specimen differs considerably in its outlines from the one figured in the original description, the difference is not so great as I have seen in other species, due to difference in treatment.

Remora remora (*Echeneis remora*), *Remora, Sucker.*

FOOD.

Of the nine remoras examined the stomachs were empty in all but two; one of these contained the bones and tail of a fish resembling the menhaden; the other contained a squid.

CESTODES.

1. *Rhynchobothrium speciosum* Linton. Cysts on viscera. **4**, pp. 801–805, pl. LXIV, figs. 13, 14, and pl. LXV, figs. 1–7.

TREMATODES.

2. *Distomum lageniforme* Linton. Intestine. **6**, pp. 524–525, pl. XLVII, figs. 1, 2.
3. *Distomum monticellii* Linton. Intestine. **6**, pp. 518–520, pl. XLIV, figs. 2–8. Aug. 17, 1899; 4. Aug. 9, 1900; 7. On gills.

The preserved specimens of these two lots measure from 4 to 5 mm. in length. While living they vary, with different stages of contraction, between 4 mm. and 10 mm. In the living worm the body was transparent, slightly tinged with yellow; folds of uterus orange, lighter in posterior part of body; suckers also transparent tinged with yellow; testes, seminal vesicle, and cirrus pouch white.

Merluccius bilinearis, *Silver Hake, Whiting, Frost-fish.*

FOOD.

Stomachs empty in most of the specimens which have been examined. The following have been noted: Fragments of fish on two occasions; small crustacea in intestine of one; many crabs (*Panopeus*) in stomach and intestine of one.

ACANTHOCEPHALA.

1. *Echinorhynchus acus* Rudolphi. Intestine. One specimen, a female, July 11, 1900.

This specimen was smaller and more slender than the worms from the winter flounder and others which I have referred to this species. The proboscis is cylindrical; hooks very regularly placed, twelve in each of the eight vertical rows which are visible on one side. See **3**, p. 525, etc.

NEMATODES.

2. *Immature nematodes* (*Ascaris*). [Pl. XIII, figs. 160–162.] Serous coat of viscera. **7**, p. 282.

Found in the specimens examined in the summers of 1899 and 1900. Some of those found in 1900, which were particularly abundant on the pyloric cæca, can be recognized as young of the genus *Ascaris*. These were reddish or reddish-brown and from 5 to 16 mm. in length. Collected also by S. E. Meek, Fulton Market, New York, November, 1886. "Abdominal cavity appeared swarming with the worms. All were very lively." Dimensions of one in millimeters: Length, 22; diameter, 0.43; length of œsophagus, 2.6. Figs. 160, 161, are from the latter.

CESTODES.

3. *Dibothrium crassiceps* Rudolphi. Intestine. [Pl. XXIV, figs. 266–268.] Aug. 5, 1899; 1. Scolex and short strobile.

Length, 8 mm. (alcoholic); number of joints, about 40. Dimensions in millimeters, life: Length of head, marginal view, 1; length of bothrium, lateral view—i. e., corresponding to the flat surface of the body 1.14; breadth of head, corresponding to marginal view of body 1.5, corresponding to flat surface of body 1.3; breadth of first segment, anterior 0.78, posterior 1.07, thickness 0.36. Posterior segments show rudiments only of the reproductive organs, but no indication of external genital opening. The cuticle is covered with minute spines. In the alcoholic specimen the head is nearly spherical. See No. 6, under *Pomatomus saltatrix*.

4. *Dibothrium angustatum* Rudolphi. Intestine. [Pl. XXIV, figs. 269, *a*, *b*, *c*.]

Thirty-seven young strobiles, August 21, 1899. These agree closely with Diesing's synopsis of this species: "Head elongate, tetragonal, slender, with oblong lateral bothria; neck very short. First segments elongated, very narrow; succeeding segments shorter, subquadrate."

The outline of the head varies with the state of contraction, but the prevailing form is linear-oblong or somewhat clavate. Segments slender, almost cylindrical, slightly enlarged at their posterior ends. Dimensions of an alcoholic specimen in millimeters: Length of head, 1.16; breadth, anterior 0.33, greatest breadth 0.33, posterior 0.19. Another: Length of head, 1.21; breadth, anterior 0.22, greatest breadth 0.26, posterior 0.17. Longest head measured 1.92 mm. in length to the first distinct segment. The strobiles are linear or nearly so and measured about 25 mm. in length.

5. *Phyllobothrium* sp. Immature. Intestine. [Pl. XX, figs. 231, 232.]

Three specimens collected July 11, 1900, bear some resemblance to larvæ which are not infrequent in the common squid. (**4**, p. 792, pl. LXII, figs. 1–9.) Head white, with four bothria, which have crumpled borders and an auxiliary acetabulum on anterior border of each. There is also a muscular sucker (myzorhynchus) on anterior part of head between the bothria. Neck linear, ligulate, translucent, the vessels of water vascular system showing plainly as sinuous lateral lines, in preserved specimens, filiform. Body fusiform, appressed, opaque, pinkish. The largest specimen measured in life 44 mm. in length. Length of head, 3 mm.; of head and neck, 26 mm.; of body, 18 mm.

6. *Rhynchobothrium* sp. Encysted on viscera, especially on pyloric cæca. **7**, p. 282. Found also in 1899 and 1900.

Immense numbers of small pyriform cysts, 2 to 5 mm. long, were found on pyloric cæca of a silver hake, July 11, 1900. Dimensions of one of these larvæ in millimeters: Length, 3; length of head, 0.87; of contractile bulbs, 1.02; of proboscides, estimated, 1.74; diameter of proboscis, including hooks, 0.15; length of longer hooks, 0.07; diameter of contractile bulbs, 0.12. The hooks differ from any I have yet seen, bearing some resemblance to those of *Tetrarhynchus erinaceus*. [Pl. XXII, figs. 251–254.]

7. *Larval cestodes* (*Scolex polymorphus* Dujardin). Free in intestine. **7**, p. 282. See **4**, p. 789, etc. Found also in 1899 and 1900.

TREMATODES.

8. *Distomum ocreatum* Molin. Intestine. See **4**, p. 514, etc. **7**, pp. 282, 288, pl. XXXV, figs. 16–24. Found also Aug. 21, 1899; 10.

9. *Distomum vitellosum* Linton. Intestine. **7**, pp. 282, 290. Found Aug. 21, 1899; 18. [Pl. XXX, fig. 335.]

Pollachius virens, *Pollock*.

NEMATODES.

1. *Ascaris clavata* Rudolphi. Stomach. **7**, pp. 283, 302, pl. XLIII, figs. 105–108.

In the U. S. National Museum collection there are three specimens from the pollock which evidently belong to this species. While they, together with those from the cod, present many variations, they agree in having the posterior end truncated and the upper lip oblong with a somewhat cylindrical pulp. The side membranes were not easily seen in all. The adults of both sexes are more attenuate anteriorly than posteriorly, while the males are shorter and relatively stouter than the females. See under *Gadus callarias*, No. 2.

1*a*. *Immature nematodes.*

Six lots in U. S. National Museum collection from body cavity. Specimens inclosed in embryonic cuticle. Length about 24 mm., head truncate, tail with mucronate tip. Collected in October and November, 1886.

CESTODES.

2. *Rhynchobothrium*. Larvæ encysted on mesentery. **7**, p. 283.

TREMATODES.

3. *Dactylocotyle denticulatum* Olsson. [*Octobothrium denticulatum* Olsson.] Gills. **7**, pp. 283, 286, pl. XXXIII, figs. 6–10.

4. *Distomum ocreatum* Molin. Stomach. **7**, pp. 283, 288, pl. XXXV, figs. 16–24. See **6**, pp. 514–515, pl. XLII, fig. 13.

Microgadus tomcod, *Tomcod.*

FOOD.

Annelids, shrimp, amphipods, and other small crustaceans found in the alimentary canals.

NEMATODES.

1. *Ascaris* sp. [Pl. IX, figs. 97–99.] Immature. Intestine. Found in July 1886, Aug. 1887, and 1899; few. In intestine near pyloric cæca; length, 25 to 35 mm; probably the young of *Ascaris clavata*.

CESTODES.

2. *Larval cestodes* (*Scolex polymorphus* Dujardin). Free in intestine. Aug. 2, 1900. See **4**, p. 789, etc.
3. *Rhynchobothrium imparispine* Linton. Encysted on viscera. **4**, pp. 799–801, pl. LXIV, figs. 9–12.
4. *Rhynchobothrium* sp. Encysted, submucosa of intestine and peritoneum. **4**, p. 794, pl. LXIII, fig. 2.

TREMATODES.

5. *Distomum appendiculatum* Rudolphi. Intestine. Aug. 2, 1900. See **7**, p. 289, pl. XXXVI, figs. 25, 26.
6. *Distomum simplex* Rudolphi. Intestine. [Pl. XXX, figs. 331, 332.] **6**, pp. 525–526, pl. XLVII, figs. 6, 7. Aug. 13, 1900; 3.

These distomes when first seen were yellowish white, nearly transparent, the surface corrugated by fine transverse lines. They then resembled very closely the small distomes (No. 19 under P. *dentatus* [fig. 336]) from the flounder collected August 17, 1899. When a specimen, which was quite short and corrugated and kept under slight pressure, was held over the flame of an alcohol lamp and warmed sufficiently to stiffen it, the body relaxed and became much elongated. After seeing the diverse shapes which distomes of the same species assume under different conditions of development and contraction one realizes the inadvisability of bestowing specific names on new forms in the absence of a good number of specimens. These specimens varied from 1.22 mm. to 2.47 mm. in length. A few dimensions of a specimen in glycerine given in millimeters are: Length, 2.40; breadth, 0.44; oral sucker, length 0.19, breadth 0.17; diameter of pharynx, 0.09; acetabulum, length 0.25, breadth 0.29; ova, 0.08 and 0.04 in the two principal diameters.

Gadus callarias (*Gadus morrhua*), *Cod.*

ACANTHOCEPHALA.

1. *Echinorhynchus acus* Rudolphi.

Eleven lots in the National Museum collection from Woods Hole, collected in November and December, 1887; two in January, 1888, by Mr. Vinal N. Edwards; one collected August 22, 1883, and one from Eastport, Me. (Palmer, collector). Three of these lots contain very numerous specimens; the others range from 1 to 54. These specimens from the cod, while showing considerable variety in shape and size, agree closely in the maximum and minimum dimensions. The females in nearly every lot measure from 28 mm. to 30 mm. in length, and the males from 6 mm. to 8 mm.

NEMATODES.

2. *Ascaris clavata* Rudolphi. Stomach.

Eleven lots of nematodes from this host, seven collected at Woods Hole, by Vinal N. Edwards, in November, December, 1887, and January, 1888; one lot collected by Mr. Thomas Lee on the steamer *Albatross*, August 22, 1883; one from a salt cod, collected by Mr. A. H. Clark; one from Long Island, collected by Mr. S. E. Meek, and one from Casco Bay, while presenting many individual variations, appear to belong to this species. The specimens in these lots vary from 6 mm. to 62 mm. in length. The smaller are relatively more slender than the larger ones, which were considerably thickened posteriorly.

Dimensions of two specimens, in millimeters: Length, male 30, female 48; diameter of head, male 0.28, female 0.30; diameter 2 mm. back of head, male 0.80, female 0.70; diameter middle, male 0.85, female 1.10; diameter 2 mm. from posterior end, male 0.80, female 1; diameter at anal aperture, male 0.25, female 0.35; distance of anal aperture from posterior end, male 0.15, female 0.28.

The adults of both sexes are more attenuate anteriorly than posteriorly, while the males are shorter and relatively stouter than the females. In the female from which the measurements given above were taken the upper lip was unsymmetrical, oblong, length 0.2 mm. and breadth 0.22 mm. The tip of the tail usually mucronate and minutely roughened or beset with short spicules. The majority of specimens in these lots were immature, and but few males were noticed. The anal papillæ were but imperfectly made out; no postanal papillæ were noted in males examined; 23 or 24 preanal papillæ on a side were counted, the posterior 8 or 10 small, pediceled, and capitate. The remainder, including a pair immediately in front of the anal aperture near the median line, are larger and not capitate. The number appears to be the same on each side.

The smaller specimens were smooth; the larger often transversely rugose, especially toward the posterior end. The lateral alæ appear to be an adult character. See under *Pollachius virens*, No. 1, and **7**, pp. 283, 302, pl. XXXVIII, figs. 105–108.

3. *Immature nematodes* (*Ascaris*). Serous covering of stomach, intestine, liver, etc.

I have examined nine lots of nematodes which came from capsules in various parts of the body cavity of the cod. The greater part of these were collected by Mr. Vinal N. Edwards in the months of November and December, 1887. These specimens for the most part agree with descriptions of *Ascaris capsularia;* that is to say, they are immature ascarids. Specimens were found, however, which were sufficiently developed to make it appear highly probable that they are the young of *Ascaris clavata*. The larger specimens range from 25 to 40 mm. in length, and from 0.6 to 1.1 mm. in diameter.

4. *Cucullanus globosus* Zeder. [Pl. XVII, fig. 206.]

Nine specimens from the cod, collected by Mr. Vinal N. Edwards in the months of November, December, 1887, and January, 1888, belong to this species. Dimensions in millimeters: Length, male 10.5, female 15; diameter, male 0.4, female 0.35. Tail of female slender and prolonged 0.5 mm. beyond the anal aperture. Length of male copulatory spines, 1.2 mm.

CESTODES.

5. *Dibothrium rugosum* Rudolphi. Pyloric cæca. **2**, pp. 750–754, pl. III, figs. 7–10. **5**, p. 431, pl. XXVIII, figs. 9, 10, and pl. XXIX, figs. 1–4.
6. *Rhynchobothrium imparispine* Linton. Peritoneum. **4**, pp. 799–801, pl. LXIV, figs. 9–12. See **2**, pp. 840–843, pl. XII, figs. 6–9.

TREMATODES.

7. *Nitzschia papillosa* Linton. **6**, p. 508, pl. XL, fig. 1–6.
8. *Distomum rachion* Cobbold (?). **6**, pp. 538–539, pl. LIII, figs. 3–7.

Melanogrammus æglefinus, *Haddock*.

ACANTHOCEPHALA.

1. *Echinorhynchus acus* Rudolphi. See **3**, p. 525, etc.

Found in two lots of entozoa from this host, collected by Vinal N. Edwards in the months of November, 1886, and December, 1885, 10 in one, 4 in the other. The longest, a female, measured 45 mm.; the shortest, a male, 6 mm.

NEMATODES.

2. *Nematodes*. Immature. Encapsuled on peritoneum.

Three lots of encapsuled nematodes from this host in U. S. Nat. Mus. collection. These were collected by V. N. Edwards in November, 1886, and December, 1885. The specimens in two of these lots agree with those from the cod, and are probably the young of *Ascaris clavata*. The longest is about 30 mm. in length. The specimens in the third lot resemble Cobbold's *A. acanthocaudata*. Body nearly filiform, but tapers more anteriorly than posteriorly. Dimensions in millimeters: Length, 28; diameter of body 0.75, of head 0.25; distance of anal aperture from posterior end, 0.3; length of œsophagus, 4. In acetic acid two systems of diagonal fibers were brought out.

CESTODES.

3. *Rhynchobothrium imparispine* Linton. Peritoneum. **4**, pp. 799–801, pl. LXIV, figs. 9–12.

Antimora viola.

NEMATODES.

1. *Immature nematodes.* [Pl. XIII, figs. 163–165.]

Seven specimens from peritoneum; U. S. Fish Commission steamer *Albatross*, 811 fathoms. These specimens, which are young ascarids, have the body covered with a thin embryonic investment, which is thrown into transverse folds, raised from the body, and in places sloughing off. In some of the specimens rudimentary lips can be seen. Dimensions in millimeters: Length, 28; diameter of head 0.12, middle 0.5, at anal aperture 0.15; distance of anal aperture from posterior end, 0.15.

Phycis tenuis, *Hake.*

FOOD.

The stomachs examined by me have been empty. The intestines of some alcoholic specimens contained a whitish chyle, which became chalky when dry and contained a large proportion of carbonate of lime.

NEMATODES.

1. *Ascaris* sp. [Pl. VIII, figs. 75–78.]

One specimen, a female, collected by Vinal N. Edwards, November, 1888, appears to be near *A. clavata.* Some of its dimensions in millimeters are: Length, 84; diameter of head 0.36, 1 mm. back of head 0.65, near middle (maximum) 1.85, 1 mm. from posterior end 1.12, at anal aperture 0.72; distance from anal aperture to posterior end 0.37; length of upper lip 0.28, breadth 0.26.

The specimen is attenuate for the anterior third, posterior end coiled; diameter nearly uniform from middle to posterior end. The upper lip is unsymmetrical and no papillæ were seen on it. No lateral alæ were observed.

2. *Immature nematodes* (*Ascaris*). From body cavity. [Pl. XIII, figs. 166, 167.]

Six lots in the U. S. National Museum collection taken from fish captured off Marthas Vineyard in connection with work of the U. S. Fish Commission; one lot collected at Woods Hole, August 28, 1889. The specimens are for the most part from the outside of the alimentary canal. The bottles contained several stomachs and intestines and a single specimen was found in one of the stomachs. This was compared with specimens taken from capsules in the mesentery and found to be identical. Dimensions in millimeters: Length, 21; diameter, head 0.10, near head 0.3, middle 0.44, near posterior 0.3, at anal aperture 0.15; distance anal aperture to posterior end 0.25. The outlines of the young ascaris could be made out within the embryonic cuticle.

3. *Filaria serrata* sp. nov. [Pl. XV, figs. 192–196.] Off Nantucket, 65 fathoms, Aug. 23, 1883.

Body armed with circles of short triangular spines. First circle about 0.1 mm. from the anterior end, length of spines 0.01 mm. The circles become rather indistinct back of the eighteenth, but continue until their number is over 100, as could be seen along the margins of optical sections of the worm. The spines become smaller in the posterior circles. Dimensions of male in millimeters: Length, 5.8; diameter in front of first circle of spines 0.06, at first circle 0.07, middle 0.1, at anal aperture 0.06; distance of anal aperture from posterior end 0.16; lengths of copulatory spines 0.06 and 0.03. Female (specimens not quite complete): Length, 6.5; diameter at first circle of spines, 0.08; maximum diameter, 0.18; ova, 0.04 and 0.02 mm. in the two principal diameters. In the males the œsophagus is sinuous and the anterior end seemed to be inverted. The copulatory spines are unequal, one being long, slender, and sharp-pointed; the other shorter, a little broader, appears to be forked at the base and blunt at the tip. Six postanal and four preanal papillæ were made out on each side. The two posterior papillæ on each side are much smaller than the others and were seen in only one of the specimens.

The male is further characterized by having four longitudinal, serrate rows of small plates in front of the anal aperture. The length of these rows in one specimen was 0.35 mm. The component plates 0.001 mm. in height, of varying length; some measured 0.005 in length.

CESTODES.

4. *Rhynchobothrium.* Cysts on viscera. **4**, p. 795.

TREMATODES.

5. *Distomum hispidum* Abildgaard. Intestine. [Pl. xxix, figs. 321–323.]

Taken by the schooner *Grampus*, south of Marthas Vineyard, in 65 to 70 fathoms, July 30, 1900; 15. Collected by Mr. C. W. Stone. These distomes are from 3 mm. to 6 mm. in length. The necks are densely clothed with large, coarse spines, and the body covered with short spines; acetabulum much larger than oral sucker. Dimensions in millimeters of a specimen in glycerine somewhat compressed: Length, 4.26; diameter of oral sucker, 0.17; diameter of acetabulum, 0.45; breadth of body, middle, 1.16; diameter of anterior testis, 0.5; length of posterior testis 0.77, breadth 0.5; ovum, 0.086 and 0.055 mm. in the two principal diameters. So far as these specimens have been studied, they agree closely with this species, except that the neck is flattened and tapers gradually but uniformly to the bluntly rounded anterior end, instead of being dilated at its middle part.

Urophycis chuss (*Phycis chuss*), *Hake.*

FOOD.

Shrimps and amphipods noted in alimentary canal of one taken in 30 fathoms off Gay Head, August 5, 1899. Small crustaceans and lenses of small fish in alimentary canals of four young hake taken in Katama Bay, August 30, 1899.

ACANTHOCEPHALA.

1. *Echinorhynchus acus* Rudolphi. Intestine. See **3**, p. 525, etc. Aug. 5, 1899, 19 specimens.

These specimens are smaller and more slender than examples from other hosts, e. g., the flounders, but they appear to agree in all essential particulars with this species.

NEMATODES.

2. *Immature nematodes* (*Ascaris*). Peritoneum.

A small lot belonging to the U. S. National Museum collection, collected by the U. S. Fish Commission in 1887, agree with those mentioned under *Phycis tenuis* No. 2. Also found August 5, 1899, numerous; and August 2, 1900. [Pl. vi, figs. 53, 54.] Identical with No. 2 under *Lopholatilus chamæleonticeps* and No. 2 under *Paralichthys oblongus.*

CESTODES.

3. *Rhynchobothrium.* Encysted on peritoneum. **4**, p. 796. Also found Aug. 5, 1899.

TREMATODES.

4. *Distomum ocreatum* Molin. Intestine. See **7**, p. 288, pl. xxxv, figs. 16–24. Aug. 5, 1899; numerous.

These agree fairly well with this species. The oral sucker exceeds the acetabulum slightly in the preserved specimens, which are contracted and measure 1 mm. or less, excluding the appendix. Ova 0.024 and 0.014 in the two principal diameters.

5. *Distomum appendiculatum* Rudolphi. Intestine. See **7**, p. 289, pl. xxxvi, figs. 25, 26.

Twenty-one distomes from two young hake, seined in Katama Bay, August 28, 1900, are to be referred to this species. They were very active and variable in form. At rest the length is about 2.6 mm. Diameter of oral sucker, 0.09 mm.; of acetabulum, 0.19 mm.; body serrate, neck very short, cirrus pouch behind acetabulum; vitellaria, two and globular; ova, 0.024 and 0.010 mm. in the two principal diameters.

Enchelyopus cimbrius, *Four-bearded Rockling.*

FOOD.

But one specimen examined. This was taken in the trawl net in about 30 fathoms of water off Gay Head, August 5, 1899. Shrimps, amphipods, and a few small univalve mollusks in the alimentary canal.

ACANTHOCEPHALA.

1. *Echinorhynchus acus* Rudolphi. Intestine. One female; agrees with this species in all essentials. See **3**, p. 525, etc.

NEMATODES.

2. *Immature nematodes.*

Rather numerous; different sizes, but all small and immature. Dimensions of one in millimeters: Length, 18; diameter, anterior 0.09, middle 0.6, at base of œsophagus 0.38, at anal aperture 0.19; distance of anal aperture from posterior end, 0.25; length of œsophagus, 0.65. Diverticulum from œsophagus at its juncture with the intestine.

TREMATODES.

3. *Distomum* sp. [Pl. XXIX, fig. 330.]

A small number obtained from the intestine. These resemble *D. tenue*, but oral spines are wanting. The following characterization is based on alcoholic specimens: Body elongate, linear, depressed; neck slightly elongate, equaling about one-fifth of the whole length, armed with minute, flat spines; mouth unarmed; oral sucker somewhat smaller than acetabulum, nearly globular, but with notch on posterior inner border; acetabulum nearly globular, transverse diameter exceeding the length; pharynx oblong, separated by a distance equal to its length from the oral sucker and followed by an œsophagus of equal length; intestinal rami simple, elongate, extending to near the posterior end of the body; testes, two in posterior half, occupying nearly whole diameter of the body, separated from each other by a space equal to the diameter of each; anterior testis preceded by the globular ovary; ova relatively few (50, more or less) and large; vitellaria generally distributed in the body back of acetabulum, especially at posterior end and along margins, in transverse sections appearing as subglobular bodies around the periphery; seminal receptacle dorsal to acetabulum; genital opening in front of the acetabulum and close to it on the median line.

Dimensions of specimen cleared in acetic acid, slightly compressed, in millimeters: Length, 3.62; diameter, middle of neck 0.32, maximum 0.5, near posterior end 0.3, transverse of oral sucker 0.13 (in another specimen 0.11), transverse of acetabulum 0.17 (in another 0.13); pharynx, length 0.12, breadth 0.07; diameter, of ovary 0.23, of anterior testis 0.32, of posterior testis 0.35; ova, 0.07 and 0.04 in the two principal diameters. Spines seen only on the neck, longest on ventral side of neck, where they are about 0.006 mm. in length. In one specimen the oral sucker nearly equaled the acetabulum, the diameters being 0.27 and 0.29 mm. These specimens resemble *D. increscens* Olsson, but differ from that species in the proportions of the suckers and in the position of the genital aperture.

Brosmius brosme, *Ling.*

U. S. National Museum collection. The label reads: "Ling, stomach, U. S. Fish Commission steamer *Albatross*, station 2577, 1885." This station was established September 4, 1885, off Marthas Vineyard; depth, 32 fathoms.

NEMATODES.

1. *Ascaris* sp. Immature. Stomach.

Ten and 3 fragments. Length, about 25 mm.; attenuate anteriorly, thickened toward posterior end, which is short-pointed and mucronate; surface of body crossed by fine transverse striæ, most easily seen toward the posterior end. Dimensions in millimeters of a male and a female, the dimensions of the male given first: Length, 25 and 25; diameter of head 0.2 and 0.2, 2 mm. back of head 0.35 and 0.45, middle 0.50 and 0.63, 2 mm. from posterior end 0.6 and 0.62, at anal aperture 0.15 and 0.3; distance of anal aperture from posterior end, 0.18 and 0.4; length of head, 0.15 and 0.17. The breadth of the upper lip in the male was 0.14 and its length 0.15; length of copulatory spines 1.3, of œsophagus 3; no papillæ were made out. Some variability was noted in the proportions of the upper lip in different specimens. There was, however, but little difference between the length and the breadth. The length was not less than the breadth, but it did not exceed the breadth much in any case.

Nematonurus goodei (*Macrurus asper*).

NEMATODES.

1. *Ascaris linstowi* sp. nov. Stomach. [Pl. III, figs. 23–25, and pl. IV, figs. 26–28.]

Two specimens, a male and a female, from this deep-water fish were collected from a fish taken by the U. S. Fish Commission off the southern coast of New England in 1884. While these specimens resemble Linstow's *A. macruri* and still more closely his *A. macruroidei* (Challenger Report, vol. XXIII, part LXXI, p. 7, 8, pl. I, figs. 10, 11, text figure 1), they can not be referred to either. The bodies are

attenuate anteriorly, the greatest diameter being not far from the posterior end. The postanal portion is slender but more acute in the male than in the female. In the male the posterior end is recurved. The body is crossed by very fine transverse striæ. The lips are without tooth plates. The upper lip is somewhat elliptical, its dimensions in the female being, length 0.2 mm., breadth at middle 0.19 mm., breadth at base 0.1 mm. Six postanal papillæ were made out in the male, two pairs remote from the anus and one pair near. Twelve preanal papillæ were seen—that is, two groups of three each—on each side; the papillæ in the anterior group not so close together as those in the posterior group, which lies a short distance in front of the anal aperture.

Dimensions of the two specimens in millimeters, the numbers for the male standing first: Length, 33 and 56; diameter of head 0.2 and 0.3, 2 mm. back of head 0.5 and 0.7, maximum (near posterior end) 0.68 and 1.46, 2 mm. from posterior end 0.68 and 0.9, at anal aperture 0.24 and 0.5; distance from anal aperture to posterior end 0.2 and 1.10; length of œsophagus, male 2.44; length of copulatory spines, 2.3.

Macrourus bairdii, *Baird's Grenadier.*

ACANTHOCEPHALA.

1. *Echinorhynchus acus* Rudolphi.

U. S. National Museum collection; collected by the U. S. Fish Commission, station 894. Largest specimen in this lot measures 21 mm. in length; diameter near anterior end 1.1 mm., near middle 0.8 mm., near posterior end 0.6 mm. In a male of this lot the number and arrangement of testes, cement glands, and vas deferens agreed with the specimens from the flat-fish. See **3**, p. 525, etc.

NEMATODES.

2. *Ascaris* sp. Immature. [Pl. XIV, figs. 173–178.]

U. S. National Museum collection, four lots, collected by the U. S. Fish Commission steamer *Albatross*, stations 894, 2201, and 2739. These are all immature and range in length from 15 mm. to 33 mm. In most of the specimens the embryonic cuticle was still attached, but in the process of sloughing off. There is considerable variation in the lips and in the appearance of the posterior end with the degree of development. On this account it is exceedingly difficult to characterize these immature nematodes briefly. Dimensions of one in millimeters are given: Length, 32; diameter of head 0.17, near head 0.25, middle 0.6, near posterior end 0.33, at anal aperture 0.25, 5 mm. back of head 0.65, 5 mm. from posterior end 0.55; length of œsophagus, 3.3; distance from anal aperture to posterior end, 0.45. In a specimen measuring 33 mm. in length the greatest diameter was about 10 mm. from the posterior end. The body is smooth except for exceedingly minute transverse lines; lateral jaws with about three teeth; upper lip without papillæ, at least none were made out; length and breadth of lips nearly equal. The interlip in most is very short.

3. *Undetermined nematode.* Stomach. [Pl. XIX, figs. 224–227.]

A nematode which resembles some of the free forms like *Enoplus* was found in the U. S. National Museum collection from the stomach of this host, U. S. Fish Commission station 894. This is one of the dredging stations established by the steamer *Fish Hawk*, October 2, 1880; depth, 365 fathoms. The specimens are slender-fusiform, with a tendency to assume an arcuate position. Four pairs of small, gently curving spines were counted around the mouth of one of the specimens, and a few others a short distance back of the head. The anterior end was retracted in one so that the specimen bore some resemblance superficially to *Echinorhynchus;* posterior end acuminate. Body wall rather thick and dense, with a few delicate longitudinal fibers and exceedingly minute and crowded transverse fibers. The œsophagus is long and slender. About midway of its length a muscular sheath of coarse longitudinal fibers begins, which incloses its basal portion, and, continuing, envelops the intestine and reproductive organs. A reproductive opening was noticed in one specimen a little in front of the middle in the wall of the muscular sheath. The aperture in the outside wall did not quite coincide with it, but had probably been displaced by the distortion of the specimen under the cover glass. Dimensions in millimeters: Length, 12.5; diameter, anterior 0.12, middle 0.4, at anal aperture 0.13; distance of anal aperture from posterior end, 0.22; length of œsophagus, 1.54; distance of reproductive aperture from head, 5.5; transverse diameter of reproductive aperture 0.024, axial diameter 0.018. The reproductive aperture was surrounded by a sphincter 0.01 mm. thick.

CESTODES.

4. *Rhynchobothrium.* Cysts. **4**, p. 796, pl. LXIII, figs. 7, 8.

TREMATODES.

5. *Distomum læve* Linton. **6**, pp. 517–518, pl. XLIII, figs. 5–8; pl. XLIV, fig. 1.

Hippoglossus platessoides, *Sand-dab.*

NEMATODES.

1. *Ascaris incurva* Rudolphi (?); young.

Two immature specimens obtained from rectum of a sand-dab by Mr. B. A. Bean. The fish was taken off Race Point in 34 fathoms, August 25, 1899. The head agrees with this species; the tail, however, is too blunt unless they are immature males, which appears to be the case. Dimensions in millimeters: Length, 25; diameter, head 0.20, at base of œsophagus 0.58, middle 0.84, at anal aperture 0.23, one millimeter from posterior end 0.51; length of head 0.19, of œsophagus 3.84; distance from anal aperture to posterior end, 0.22. There appears to be an anterior prolongation of intestine parallel with œsophagus, 1.45 mm. in length. The intestine near the posterior end is capacious, with crumpled walls.

2. *Ichthyonema* sp. Intestine.

A slender nematode collected August 8, 1899. Almost the entire body was filled with elliptical ova 0.041 and 0.024 mm. in the two principal diameters. Slender attenuate anteriorly, more rapidly attenuate and acute at posterior end. Other dimensions in millimeters: Œsophagus at anterior end 0.058 in diameter, nearly cylindrical for a distance of 0.43, where it increases abruptly from 0.072 to 0.094, increasing thence to the base, where it is 0.26 in diameter; whole length of œsophagus, 3.9; length of worm, 15; diameter, anterior 0.06, middle 0.4.

Paralichthys dentatus, *Flounder.*

FOOD.

The stomachs usually contain fish and squid. In one case 18 squid were taken from the stomach of a single flounder. A hermit crab along with fish, squid, small fish and crustaceans, are other records of contents of alimentary canals of the flounder.

ACANTHOCEPHALA.

1. *Echinorhynchus acus* Rudolphi. Intestine. **3**, pp. 525–528, pl. LX, figs. 89, 90.
2. *Echinorhynchus proteus* Westrumb. On mesentery. **7**, p. 283.
3. *Echinorhynchus incrassatus* Molin. Peritoneum. **3**, pp. 533–534, pl. LVIII, figs. 54–69*a*. July 18, 1899.
4. *Echinorhynchus sagittifer* Linton. On viscera. **1**, pp. 493–496, pl. VI, figs. 1, 2. **3**, pp. 535–536, pl. LIX, fig. 80.

NEMATODES.

5. *Immature nematodes* (*Ascaris*). [Pl. XII, figs. 143–146; pl. XIII, figs. 147–151.]

Of very frequent occurrence, encapsuled in the mesentery and on the viscera, 1884 to 1889. Flounders were examined in 1899 on sixteen dates and nematodes recorded on nine of these. They were examined on five dates in 1900 and nematodes recorded on each date. They occurred in varying numbers, though only once numerous.

6. *Ascaris* (?) sp. Intestine. [Pl. VII, figs. 57–61.]

Two specimens obtained on August 9 and one on August 23, 1900; all females, active and mature. These worms are small, white, translucent. The mouth is relatively large and surrounded by three low, inconspicuous, rounded lobes, each of which is provided on its inner surface with a large number of minute teeth and apparently a single papilla. The body is short, cylindrical, truncate in front, slender pointed at posterior end. The diameter equals about one-tenth of the entire length. It is nearly uniform from the anterior end to the middle, or a little behind the middle; that is, about to the genital opening, whence it tapers very gradually toward the posterior end, narrowing rapidly just in front of the anus and likewise just at the anus. The tip is slender, but short acuminate. The intestine is capacious. A short anterior diverticulum embraces the base of the œsophagus on one side and a longer one on the other. The ovaries are voluminous, the genital opening a little behind the middle of the length.

Dimensions of living worm in millimeters: Length, 4; distance of genital aperture from anterior end, 2.3; length of œsophagus, 0.65; diameter of head 0.23, at genital aperture 0.38, two-tenths of a millimeter in front of the anal aperture 0.25, at anal aperture 0.09; distance of anal aperture from posterior end, 0.11.

7. *Ichthyonema sanguineum* Rudolphi. Mouth. **7**, pp. 283, 304, pl. XLIII, figs. 120, 121.

CESTODES.

8. *Larval cestodes* (*Scolex polymorphus* Dujardin). In cystic duct and free in intestine. **4**, pp. 789–792, pl. LXI, figs. 4–15. **7**, p. 283.

Found frequently in 1899 and 1900. I have not been making observations on these forms (*Scolex polymorphus*) for a good many years. I have recorded their occurrence, however, whenever observed. No doubt if special search were made for them their known range in American fishes could be greatly extended. On August 23, 1900, I noted these larvæ in the flounder, and found among them forms with a very distinct costa on the bothrium. Red pigment spots were present in the neck, and the terminal sucker was conspicuous. While I was watching them I noticed that four had attached themselves to the scolex of a tetrarhynchus, which was in the same dish, thus becoming ecto-parasites, or carnivorous enemies of the latter.

9. *Rhynchobothrium bulbifer* Linton. Cysts on viscera.

Larval cestodes encysted in the mesentery are very common, and have been noted on various occasions. Many of them have been too immature for identification. Noted on six dates in 1899 and on four in 1900. **4**, p. 767. **7**, p. 283. Some of these small cysts contained larvæ with proboscides resembling those figured in **4**, pl. LXIII, fig. 12.

10. *Rhynchobothrium imparispine* Linton. On viscera. **4**, pp. 799–801, pl. LXIV, figs. 9–12.

11. *Rhynchobothrium heterospine* Linton. On viscera. **7**, p. 283. See **4**, p. 799, pl. LXIV, figs. 3–8.

12. *Rhynchobothrium speciosum* Linton. On viscera. **4**, pp. 801–805, pl. LXIV, figs. 13, 14, and pl. LXV, figs. 1–7.

13. *Tetrarhynchus bisulcatus* Linton. In submucosa of stomach. **4**, pp. 810–811, pl. LXVI, figs. 11–15. **7**, p. 283.

Cysts with larvæ (*Tetrarhynchus*) found very frequently in submucosa of stomach in 1899 and 1900. Some appear to be *T. robustus* (**4**, p. 452), but the most of them are *T. bisulcatus*.

14. *Tetrarhynchus bicolor* Bartels.

A single specimen, August 15, 1899, in material washed out of alimentary canal. Color, white. In other particulars it agrees with this species; length, 3.5 mm. See **4**, pp. 813–815, pl. LXVIII, figs. 1–6.

15. *Synbothrium filicolle* Linton. Encysted in stomach wall. **4**, p. 817, pl. LXVIII, fig. 8.

TREMATODES.

16. *Diclidophora affinis* Linton. [*Octoplectanum affine* Linton.] Mouth. **4**, pp. 511–512, pl. XL, figs. 10–13, and pl. XLI, figs. 1–5. Found twice in 1899 and once in 1900, one in each find.

17. *Distomum appendiculatum* Rudolphi. Intestine. **7**, pp. 283, 289, pl. XXXVI, figs. 25, 26. July 15, 1899; 2.

18. *Distomum monticellii* Linton. Intestine. Aug. 18, 1899; 1. See **4**, pp. 518–520, pl. XLIV, figs. 2–8.

19. *Distomum vitellosum* Linton. Intestine. Aug. 23, 1899. July 26, 1900, few. See **7**, p. 290, pl. XXXVII, figs. 38, 39.

Two small distomes were obtained from a flounder from Muskeget Channel, August 17, 1899, which resemble this species in the general arrangement of the reproductive organs and proportions of the acetabula, etc. The bodies, however, were transversely corrugated in a very peculiar manner. This has been alluded to under *Microgadus* (No. 6, *D. simplex*). The posterior edge of the acetabulum was deeply notched so as to form two or three blunt, digitate lobes. [Pl. XXX, fig. 336.]

20. *Distomum pudens* Linton. **7**, pp. 283, 290–291, pl. XXXVII, figs. 40–47.

21. *Distomum* sp. [Pl. XXXI, fig. 345, pl. XXXII, fig. 352.]

Three small distomes collected August 22, 1899, are here referred to briefly. They bear a close resemblance to No. 11 under *Rhombus triacanthus*. One of these was sketched at the time of collecting (fig. 352). This specimen bears some resemblance to *D. pudens*, but the œsophagus is much longer

than in the forms upon which that species was based. No spines were noted, but the body was crossed by fine transverse striæ. Dimensions of living specimen in millimeters: Length, 1.19; diameter, anterior 0.08, middle 0.23, of oral sucker 0.07, of acetabulum 0.07; ova, 0.052 and 0.034 in the two principal diameters. Spherical bodies were noted in the excretory vessels. Associated with this distome were two smaller, oval, minutely spinose distomes. Dimensions, life, in millimeters: Length, 0.73; diameter, anterior 0.1, middle 0.34, of anterior sucker 0.07, acetabulum 0.08; ova, 0.065 and 0.04 mm. in the two principal diameters; diameter of spherical bodies, 0.02. An immature distome collected August 30 probably belongs to this species (fig. 345). Some of these small oval distomes resemble *D. pyriforme*.

22. *Distomum dentatum* Linton. Intestine. **7**, pp. 283, 294, pl. XXXIX, figs. 64–67.

Found on seven different dates in 1899. July 26, 1900, adults with ova, smaller without; the young were relatively much more slender than the adults. August 9, 1900; numerous. August 10, 1900; about 12, large and small. The following note was made at the time of collecting the specimens referred to this species on August 9: Younger specimens translucent, bluish, older specimens yellowish. A few of the older ones without spines thought at first to be different species. Seen by making comparative measurements to be the same except for the matter of spines, and that the ova in the spineless ones seemed to be a little larger. Either these spineless forms will prove to belong to some species like *D. vitellosum* or *D. simplex* or they will have to be regarded as examples of *D. dentatum* which have lost not only the large spines from the mouth, but the smaller spines from the body as well. A reexamination of these specimens leads me to conclude that those which do not have the spines around the mouth belong to this species. The oral spines are evidently lost in the older worms. Three distomes collected August 14, 1899, were thought at first to belong to a different species, on account of what appeared to be a peculiarity in the structure of the oral spines. These appeared to be directed forward and to be hastate in shape. This appearance was later found to be due to the fact that the oral sucker was everted to such an extent as to bring the bases of the spines in focus first. The only important differences observable between these specimens and the *D. dentatum* as originally described is that the opening of the acetabulum is round instead of transverse, and the pharynx pyriform, broader than long, in alcoholic specimens, but such characters should be given little weight in the determination of distomes. The following measurements are given for the purpose of comparison with those given in the description of the species. Dimensions of living specimen in millimeters: Length, 2.86; diameter at anterior sucker 0.29, at acetabulum 0.76, middle 0.75, posterior 0.42; oral sucker, length 0.24, breadth 0.24; acetabulum, length 0.23, breadth 0.24; pharynx, length 0.19, breadth 0.18; length of oral spines, longer 0.03, shorter 0.02; length of body spines, 0.017; ova, 0.079 and 0.041 in the two principal diameters. Dimensions of alcoholic specimen in millimeters: Length, 2.03; transverse diameter of oral sucker 0.17, of acetabulum 0.2; pharynx, length 0.1, breadth 0.16; ova, length from 0.055 to 0.072, breadth 0.038 to 0.041; anterior border of acetabulum 0.5 from anterior end. The distome noted in **7**, p. 296, pl. XL, figs. 73–75, may be a specimen of *D. dentatum* which has lost the oral spines.

RHYNCHOBDELLIDA.

23. *Leech*. From mouth. This is probably a young specimen of *Pontobdella rapax* Verrill. See under *Stenotomus*, No. 14.

The specimen was red when first seen. After lying overnight in water it became yellowish green, and when put in Gilson's mercuro-nitric solution changed to a decided grass-green. July 24, 1899. Dimensions in millimeters, alcoholic: Length, 8.25; diameter (maximum) of body 0.42, of posterior sucker 0.57, of anterior sucker 0.42, of neck 0.28.

Paralichthys oblongus, *Four-spotted Flounder*.

FOOD.

August 5, 1899; 4. Taken in the trawl in about 30 fathoms of water off Gay Head: Shrimps, amphipods, and other small crustaceans, annelids, a small lamellibranch mollusk, shell of *Utriculus canaliculatus*, and another univalve shell with a worm tube on it in alimentary tracts. Aug. 16, 1899; 4. Large numbers of amphipods, shrimps, etc., a few small crabs, and small fish in alimentary tracts. August 2, 1900; 4. Taken in Muskeget Channel. Small crabs (*Cancer*) and shrimps in stomach.

ACANTHOCEPHALA.

1. *Echinorhynchus acus* Rudolphi. Intestine. Aug. 16, 1899; 1. See **3**, p. 525, etc.

NEMATODES.

2. *Immature nematodes* (*Ascaris*). [Pl. XIII, figs. 152, 153.]

Found on each of the dates given above. These appear to be identical with small nematodes found in a number of different species of fish. Some of these were compared with specimens from *Urophycis chuss* and *Lopholatilus chamæleonticeps*. All of these were living at the time. They agreed in all essential characters. At the junction of the œsophagus and intestine there is a diverticulum from each, one from the intestine which extends forward parallel with the œsophagus and one from the œsophagus which extends backward parallel with the intestine.

Dimensions in millimeters of a small specimen collected August 2, 1900: Length, 10.5; diameter of head, 0.07; diameter at nerve ring, 0.17; diameter at anal aperture, 0.11; distance of nerve ring from anterior end, 0.36; length of œsophagus, 1.45; distance of anal aperture from posterior end, 0.19.

Figs. 152 and 153 are sketches of a specimen from a lot of immature nematodes collected by the U. S. Fish Commission in 1883, station 1158. Length, 22 mm., of nearly uniform diameter throughout (0.4 mm.); distance of anal aperture from posterior end, 0.15; diameter at anal aperture, 0.12.

CESTODES.

3. *Dibothrium punctatum* Rudolphi.

A small, slender, immature specimen from the intestine, collected August 16, 1899, probably belongs to this species. See **2**, pp. 731–736, pl. II, figs. 1–4.

4. *Larval cestodes* (*Scolex polymorphus* Dujardin). Free in intestine. Found both in 1899 and 1900. See **4**, pp. 789–792, etc.
5. *Rhynchobothrium*. Encysted on viscera. Found in 1899. **4**, p. 798.
6. *Tetrarhynchus bisulcatus* Linton. Submucosa of stomach. Found in 1899 and 1900. See **4**, p. 810, etc.

Bothus maculatus (*Lophopsetta maculata*), *Sand-dab, Window-pane.*

NEMATODES.

1. *Immature nematodes* (*Ascaris*).

Common in this as in the other flounders, encapsuled on viscera. A small lot in the U. S. National Museum collection from the Grand Banks (schooner *J. A. Chapman*) in poor condition, as if macerated, from turbot, here recorded. Lengths, 37 mm. to 55 mm.; greatest diameter, 2 mm. Anteriorly attenuate. [Pl. XIII, figs. 154–156.]

CESTODES.

2. *Dibothrium punctatum* Rudolphi. Intestine. **1**, pp. 731–736, pl. II, figs. 1–4. **5**, p. 430.
3. *Rhynchobothrium imparispine* Linton. **4**, pp. 799–801, pl. LXIV, figs. 9–12.

Limanda ferruginea, *Rusty Flat-fish.*

FOOD.

The alimentary tract in some cases contained enormous numbers of crustaceans; of these, amphipods were most numerous, but shrimps, schizopods, small crabs, *Caprella*, and *Squilla* also found; annelids, different species; bivalve and univalve mollusks; small fish.

ACANTHOCEPHALA.

1. *Echinorhynchus acus* Rudolphi. Intestine. **3**, p. 525, etc.

In two lots of the U. S. National Museum collection. Off Block Island, 1880. August 5, 1899. August 16, 1900; 30, a few quite small. August 2, 1900; 14.

NEMATODES.

2. *Immature nematodes* (*Ascaris*).

August 5 and 16, 1899. These are similar to immature nematodes found in a great variety of fishes. Most of those which I have seen appear to be young ascarids.

CESTODES.

3. *Dibothrium punctatum* Rudolphi. Intestine. **2**, pp. 731–736, pl. II, figs. 1–4. **5**, p. 430. **7**, p. 284. July 21, 1899; 2, length 8 mm. and 180 mm. Aug 2, 1900; 1.
4. *Larval cestodes* (*Scolex polymorphus* Dujardin). Free in intestine. **4**, pp. 789–792, pl. LXI, figs. 4–15. Aug. 2, 1900.
5. *Rhynchobothrium imparispine* Linton. July 21, 1899. Encysted on viscera. See **5**, p. 799, etc. Other Rhynchobothrium cysts not identified July 21 and August 6, 1899.

TREMATODES.

6. *Distomum vitellosum* Linton. Intestine. July 21, 1899; about 45. See **7**, p. 290.
7. *Distomum simplex* Rudolphi. Intestine. Aug. 16, 1899; 25, length 2 mm. to 4 mm.; ova, 0.099 mm. and 0.055 mm. in the two principal diameters.
8. *Distomum* sp. Intestine. [Pl. XXXII, fig. 359, and pl. XXXIII, figs. 360–362.] Aug. 16, 1899; 5. Aug. 2, 1900; 1.

These are small fusiform distomes with the following diagnostic characters: Body smooth, fusiform, thickest about the middle, tapering nearly equally to each end. Anterior sucker subterminal, circular, aperture somewhat triangular in preserved specimens. Acetabulum a little in front of middle, larger than oral sucker, aperture nearly circular. Pharynx subglobular, close to oral sucker, œsophagus distinct. Intestinal rami simple, extending to the ovary. Vitellaria distributed in the median regions of the body from testes to pharynx. Testes two, rather large, placed a little diagonally on the median line near posterior end of body. Ovary smaller than testes, subglobular or slightly lobed, situated in front of anterior testis and to the right. Ova few, large, in front of ovary. Cirrus pouch to right of acetabulum. Genital aperture about halfway between acetabulum and oral sucker, to right of median line, at about midway between pharynx and acetabulum. Dimensions of living specimen, in millimeters: Length, 2.57; diameter, anterior 0.25, middle 0.93, posterior 0.21; diameter of oral sucker 0.21, of acetabulum 0.36; anterior testis, length 0.43, breadth 0.36; posterior testis, length 0.43, breadth 0.37; ova, 0.065 and 0.041 in the two principal diameters. Length of another specimen, 1.57. Dimensions measured from transverse sections: Diameter of oral sucker 0.19, of acetabulum 0.33, of ovary 0.17, of testes, each 0.3. The ratio of oral sucker to acetabulum is somewhat different from the foregoing, their diameters in one of the specimens being 0.14 mm. and 0.17 mm. This for a specimen in glycerine. This species has some resemblance to *D. commune* Olsson. Its resemblance to the fusiform distome which I have referred to *D. bothryophoron* Olsson is only superficial.

Pseudopleuronectes americanus, *Flat-fish*, *Winter Flounder*.

FOOD.

A specimen examined August 16, 1899, had in the alimentary canal large numbers of shrimps and other small crustaceans and one small fish. Four small specimens from Katama Bay, August 30, had, in their alimentary tracts, both univalve and bivalve shells, small crustaceans, and annelids. An equal number, also small, from same locality, July 27, 1900, contained nereis and fragments of red seaweed with sand.

ACANTHOCEPHALA.

1. *Echinorhynchus acus* Rudolphi. Intestine. **1**, pp. 492–493, pl. V, figs. 7–13. **3**, pp. 525–528, pl. LIII, figs. 1–11, and pl. LX, figs. 89, 90. **7**, p. 284.

In eleven lots in U. S. National Museum collection, seven of them collected by V. N. Edwards in October, November, and December, 1887, 1888, the others taken off Newport at Fish Commission dredging stations Nos. 789, 796, 861. In most of these lots the specimens are numerous, 350 having been counted in one of them. Found in this host July 21 and August 30, 1899, and July 27, 1900.

NEMATODES.

2. *Immature nematodes* (*Ascaris*).

These resemble the forms mentioned under *P. oblongus*, No. 2, July 27, 1900.

2a. *Ascaris* sp. [Pl. IX, figs. 88, 89.]

One specimen, a male, collected July 23, 1889. Moderately attenuate anteriorly and very little

attenuate posteriorly; lips with papillæ and dentigerous; body rather rigid and crossed by uniform transverse wrinkles; no alæ; postanal region short conical, tip slightly mucronate. Two postanal papillæ seen, and at least twenty preanal papillæ counted on one side; spines, slender. Dimensions in millimeters: Length, 17; diameter of head 0.18, 1 mm. back of head 0.32, maximum 0.65, 1 mm. from posterior end 0.47, at anal aperture 0.18; distance of anal aperture from posterior end, 0.13; length of œsophagus, 2.8; upper lip, length 0.16, breadth 0.14.

CESTODES.

3. *Tetrarhynchus bisulcatus* Linton. Encysted in stomach wall. Aug. 16, 1900. See **1**, p. 810, etc.
4. *Tetrarhynchus*. Encysted on peritoneum. **1**, p. 809.

TREMATODES.

5. *Distomum appendiculatum* Rudolphi. Intestine. Aug. 16, 1899; few. See **7**, p. 289.
6. *Distomum grandiporum* Rudolphi. Intestine. Aug. 10, 1900; 1. See **6**, pp. 520–521, pl. XLIV, fig. 9.

This specimen agrees with published descriptions of this species very closely. Body smooth, translucent yellowish white by transmitted light. During life the worm was yellowish-white with reflected light, suckers pale; genitalia generally, including the uterus, opaque white; intestine conspicuous, dark brown, rami unbranched, but with irregular outline, extending to posterior end. Some of the dark-brown contents of the intestine ejected from the mouth while the worm was under pressure. The worm was very active, and the caudal appendix was long, slender, and attenuate. While under pressure the worm naturally lay on its side. In that position the acetabulum was seen to be much larger than the oral sucker. The worm showed a disposition to double up and adhere by both suckers to the posterior part of the body; while so doing considerable portions would be drawn inside the cavities of the suckers. When placed in the killing fluid it contracted to about 5 mm. and became cylindrical and plump.

7. *Distomum globiporum* Rudolphi (?). Intestine. [Pl. XXXI, fig. 347.] Aug. 30, 1899; 3.

These specimens agree very closely with descriptions of this species. About the only difference that I note is that in these the œsophagus is not longer than the pharynx. Dimensions of a specimen in glycerine given in millimeters: Length, 4.35; diameter, anterior 0.51, middle 1, posterior 0.22, of oral sucker 0.33, of acetabulum 0.36; pharynx globular, diameter 0.16; anterior testis, length, 0.58, breadth 0.62; posterior testis, length 0.53, breadth 0.58; ovary globular, diameter 0.22; ova, 0.71 and 0.50 in the two principal diameters. But one ovum was seen in the specimen measured. The ovary lies a little to the right of the median line. It is immediately preceded by the cirrus pouch. The cirrus passes to right of acetabulum and opens at its anterior border on the median line. The acetabulum is situated at about the anterior fourth. Testes close together on median line, a little back of middle. Vitellaria fill posterior part of body back of testes and extend laterally nearly to the acetabulum. These specimens closely resemble those referred to *D. simplex*, but differ in size and in the proportions of the suckers.

8. *Distomum vitellosum* Linton. Intestine. **7**, p. 290. [Pl. XXX, fig. 340, *a*, *b*.] Aug. 16, 1899.

A few small distomes, of exceedingly variable form while living, suggest *D. commune* Olsson (Ent. Skand. Hafsfisk, II, p. 13, IV, p. 79). Body smooth, cylindrical; acetabulum prominent, much larger than oral sucker. Length of alcoholic specimen, 0.87 mm.; diameter, 0.36 mm. A living specimen, 1 mm. in length when contracted, measured 1.72 mm. a few seconds afterwards. In life the transverse diameter of the oral sucker was 0.14 mm., of the acetabulum 0.24 mm. An ovum measured 0.048 and 0.031 mm. in the two principal diameters. In alcoholic specimens the body is elliptical-oblong, the neck is very short, conical. The acetabulum is twice the diameter of the oral sucker, and has a narrow, transverse opening. The œsophagus is short, the pharynx rather large and globose. The vitellaria extend from posterior end to the acetabulum. Genital aperture in front of acetabulum to the left of the median line. The habit of the body is rather stouter, and its walls appeared to be somewhat more resistant than *D. vitellosum*; otherwise the agreement with that species is very close.

9. *Distomum areolatum* Rudolphi. Aug. 5, 1899; numerous. See **7**, p. 293, pl. XXXIX, figs. 60–63.
10. *Distomum* sp. In globular cysts on viscera and in intestinal walls. Aug. 30, 1899.

PROTOZOA.

11. *Sporozoa.* [Pl. I, fig. 4.]

Two small specimens from Katama Bay were examined August 28, 1900. The walls of the intestine of one throughout almost the entire length and of the other for a short distance were completely covered with sporocysts. The cysts were irregular where crowded together; where not crowded together, which was in but few places, they were elliptical or spherical, of various sizes, but comparatively few reaching 1 mm. in diameter and none much exceeding that. Spores oblong-ovate about 0.003 mm. in length by 0.0015 mm. in diameter. Intestine where affected was chalky-white in color.

Glyptocephalus cynoglossus, *Craig Flounder.*

NEMATODES.

1. *Ascaris* sp. Immature. [Pl. IX, figs. 95, 96.]

One specimen, which agrees closely with No. 1 under *Hemitripterus americanus* in the U. S. National Museum collection; locality not given. The habit of the body is stouter than that of the specimens from the sea raven, and the upper lip is relatively larger and more oval. It is somewhat attenuate in front, increasing posteriorly; short pointed back of anal aperture, with mucronate tip. The latter, when highly magnified, is seen to be rough tuberculate and the anal aperture has prominent rounded lips. Measurements in millimeters: Length, 40; diameter of head 0.33, 3 mm. back of head 0.58, maximum 1.5, 3 mm. in front of anal aperture 1, at anal aperture 0.48; distance of anal aperture from posterior tip, 0.48.

Achirus fasciatus, *Hog-choker.*

FOOD.

Eight specimens examined August 2 and eleven on August 11, this summer (1900), had only vegetable débris (*Fucus* and eelgrass) in the alimentary canals.

TREMATODES.

1. *Distomum appendiculatum* Rudolphi. Intestine. One specimen Aug. 10, 1900. See **7**, p. 289.

This distome was found in two other species of fish (alewife and sea robin) taken in seine at the same time as the host of this worm. These fish were taken at the head of Buzzards Bay, at Wareham.

2. Two small distomes, young. [Pl. XXXI, fig. 351.]

One of these distomes, when flattened under the compressor, was elliptical in outline. Dimensions of living specimen in millimeters: Length, 0.26; breadth, 0.20; oral sucker, length 0.07, breadth 0.06; acetabulum, diameter 0.05.

Lophius piscatorius, *Goose-fish.*

FOOD.

Aug. 30, 1887.—A specimen taken south of Cuttyhunk had in its stomach a large quantity of mud which was rich in mollusca, annelids, and small crustaceans.

Aug. 5, 1899.—A small specimen had in stomach a winter flounder almost as large as the goose-fish.

Aug. 18, 1899.—Alimentary canal with fragments of fish.

ACANTHOCEPHALA.

1. *Echinorhynchus acus* Rudolphi. Intestine. **3**, p. 525, etc. **7**, p. 284. Aug., 1899; 3.
2. *Echinorhynchus incrassatus* Molin. Peritoneum. **3**, pp. 533–534, pl. LVIII, figs. 54–69*a*.

NEMATODES.

3. *Ascaris increscens* Molin. [Pl. VIII, fig. 64.]

U. S. National Museum collection; Vinal N. Edwards, collector; five specimens; females. Body slender, attenuate anteriorly, of nearly uniform size for the posterior two-thirds of the length. The

lateral alæ extend about 2 mm. back of head and are about one-tenth mm. broad at the widest part. Postanal region short, conical. Dimensions of one of the specimens in millimeters: Length, 37; diameter of head 0.18, maximum of body 0.5, 1 mm. from posterior end 0.45, at anal aperture 0.18; distance of anal aperture from posterior end, 0.15; length of œsophagus, 3.5.

4. *Immature nematodes* (*Ascaris*). [Pl. xv, figs. 185–187.]

A. From intestine. Numerous examples of immature nematodes were found in the intestine of a goose-fish August 30, 1887. Body of nearly uniform diameter, tapering nearly equally to each end; greatest diameter a little in front of middle; body crossed with regular transverse striæ. Dimensions in millimeters: Length, 8; diameter 1 mm. back of head 0.36, 1 mm. from posterior end 0.28, at anal aperture 0.11; distance of anal aperture from posterior end, 0.22; length of œsophagus, 1.5.

B. Encapsuled in peritoneum, over viscera generally, and sometimes on wall of body cavity [pl. xiv, figs. 179, 180]; often in great numbers. I have record of three finds of these worms, July and August. In the U. S. National Museum collection there are 11 lots from this host, nearly all collected by Mr. Vinal N. Edwards. In most cases the specimens are of various sizes up to 45 mm. and 48 mm. in length. In the larger specimens the posterior ends are more abruptly pointed than in the smaller, suggesting *A. increscens*. Bodies crossed by fine transverse striæ. The worms are usually coiled in a helix or flat coil, and sometimes are surrounded with a brown, waxy secretion of degenerate connective tissue in the capsule. In one lot a few were seen to be penetrating the walls of the stomach. In one of the lots three immature females were found in which the upper lip corresponds with Schneider's figure of *Ascaris rigida* Rudolphi. The body is slender, tapering for a short distance at each end, crossed by exceedingly delicate transverse striæ, which are about 0.003 mm. apart. Dimensions in millimeters: Length, 18; diameter of head 0.12, of body 0.33, at anal aperture 0.11; distance of anal aperture from posterior end, 0.15.

5. *Cucullanus globosus* Zeder. [Pl. xvii, fig. 205.]

A single specimen, a male from the intestine of a goose-fish, agrees with those from the cod, which I have referred to this species. See under *Gadus callarias*, No. 3. Dimensions, in millimeters: Length, 12; diameter of head 0.3, maximum of body near base of œsophagus 0.3; length of œsophagus, 1.55; length of copulatory spines, 1; axial diameter of bursa, 0.38.

CESTODES.

6. *Larval cestodes* (*Scolex polymorphus* Dujardin). Free in intestine. **1**, p. 454, pl. vi, figs. 8, 9. **4**, p. 789, etc. **7**, p. 284. Found also Aug. 5 and 18, 1899, and Aug. 20, 1900. On latter date numerous, with two red pigment patches in neck.
7. *Rhynchobothrium imparispine* Linton. Encysted. **4**, p. 800, pl. lxiv, fig. 12.
8. *Rhynchobothrium speciosum* Linton. Encysted. See **4**, p. 801, etc. **7**, p. 284. Found Aug. 18, 1899, in cysts on intestine.
9. *Tetrarhynchus* (?). Cysts. **4**, p. 809.

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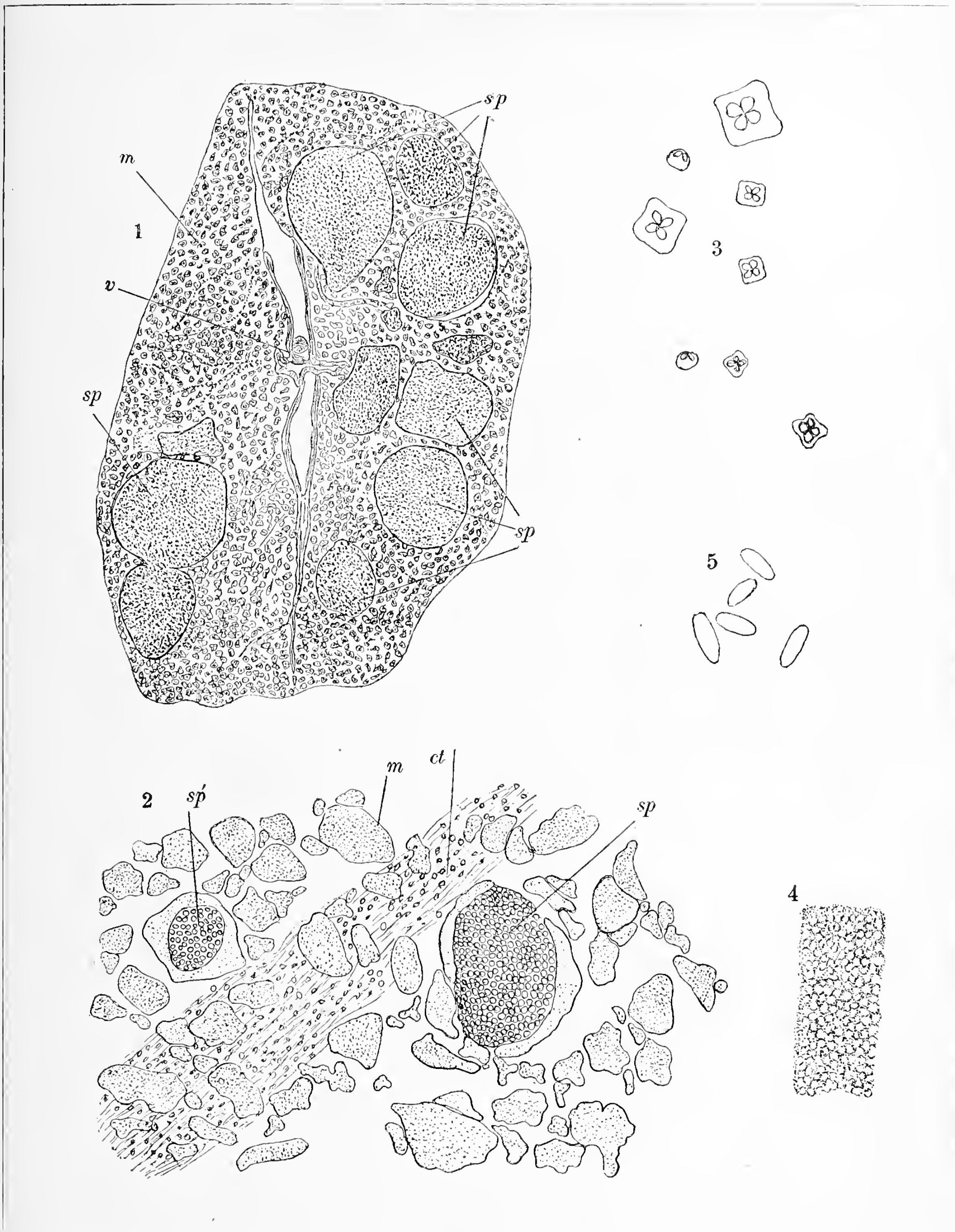
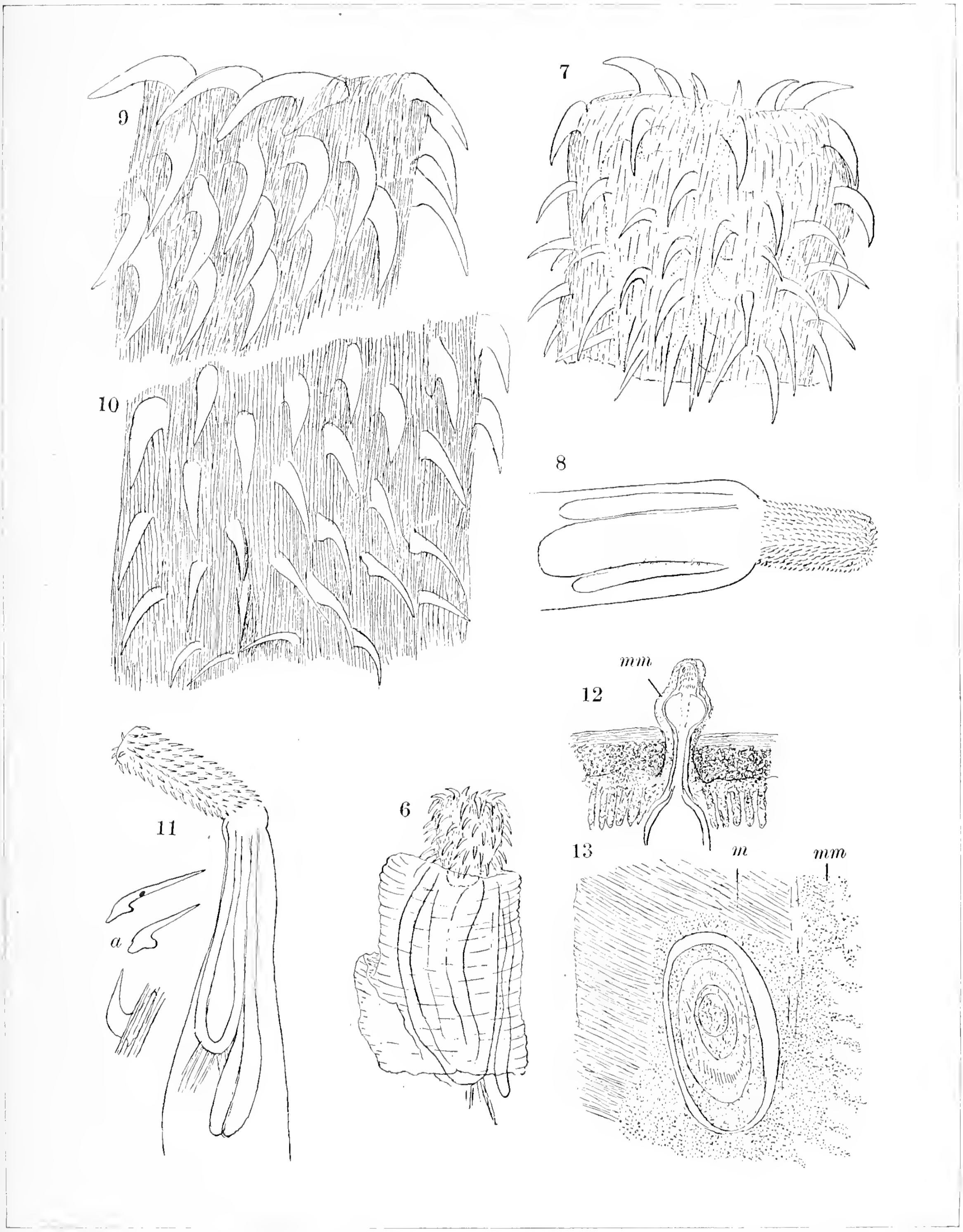
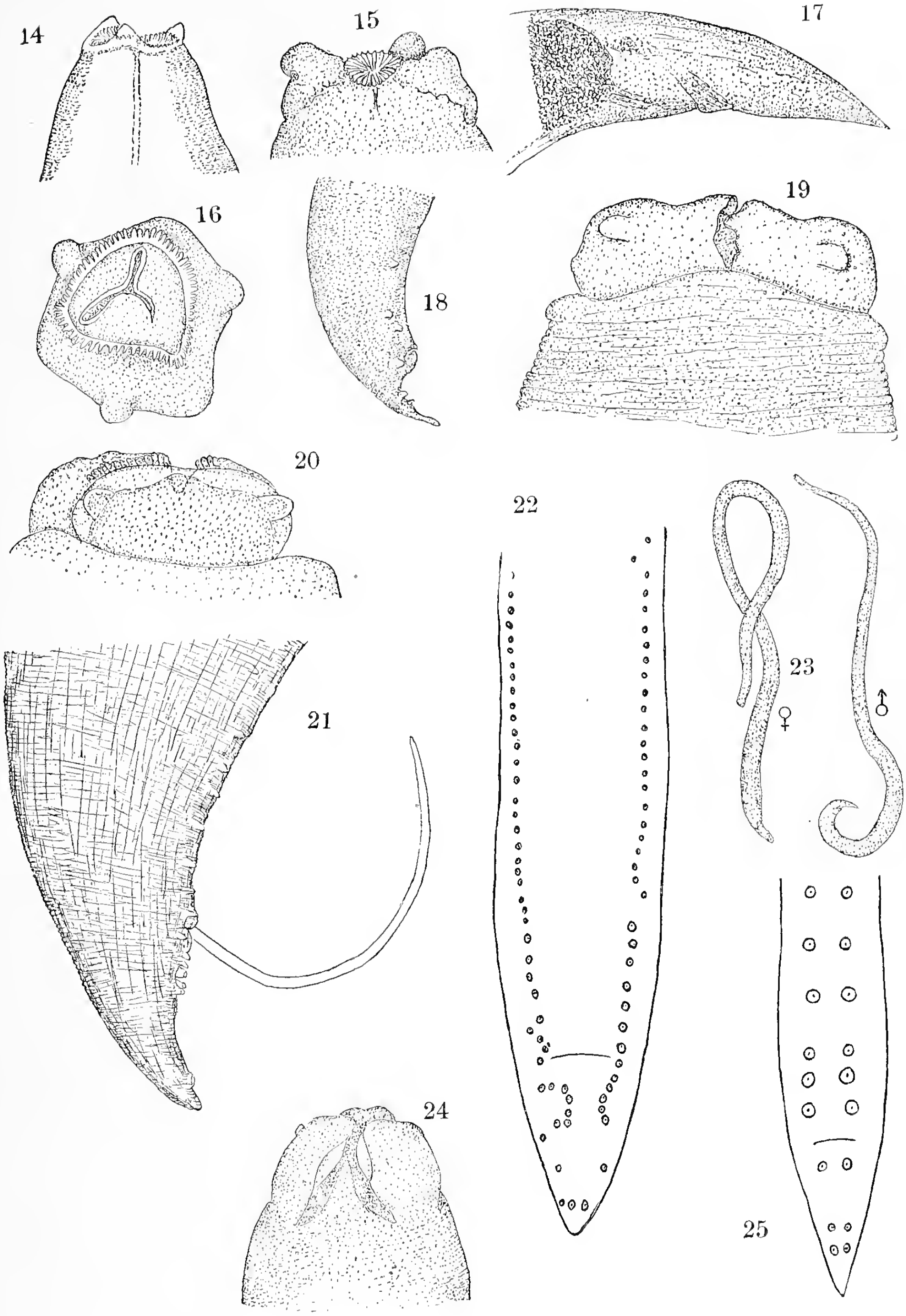


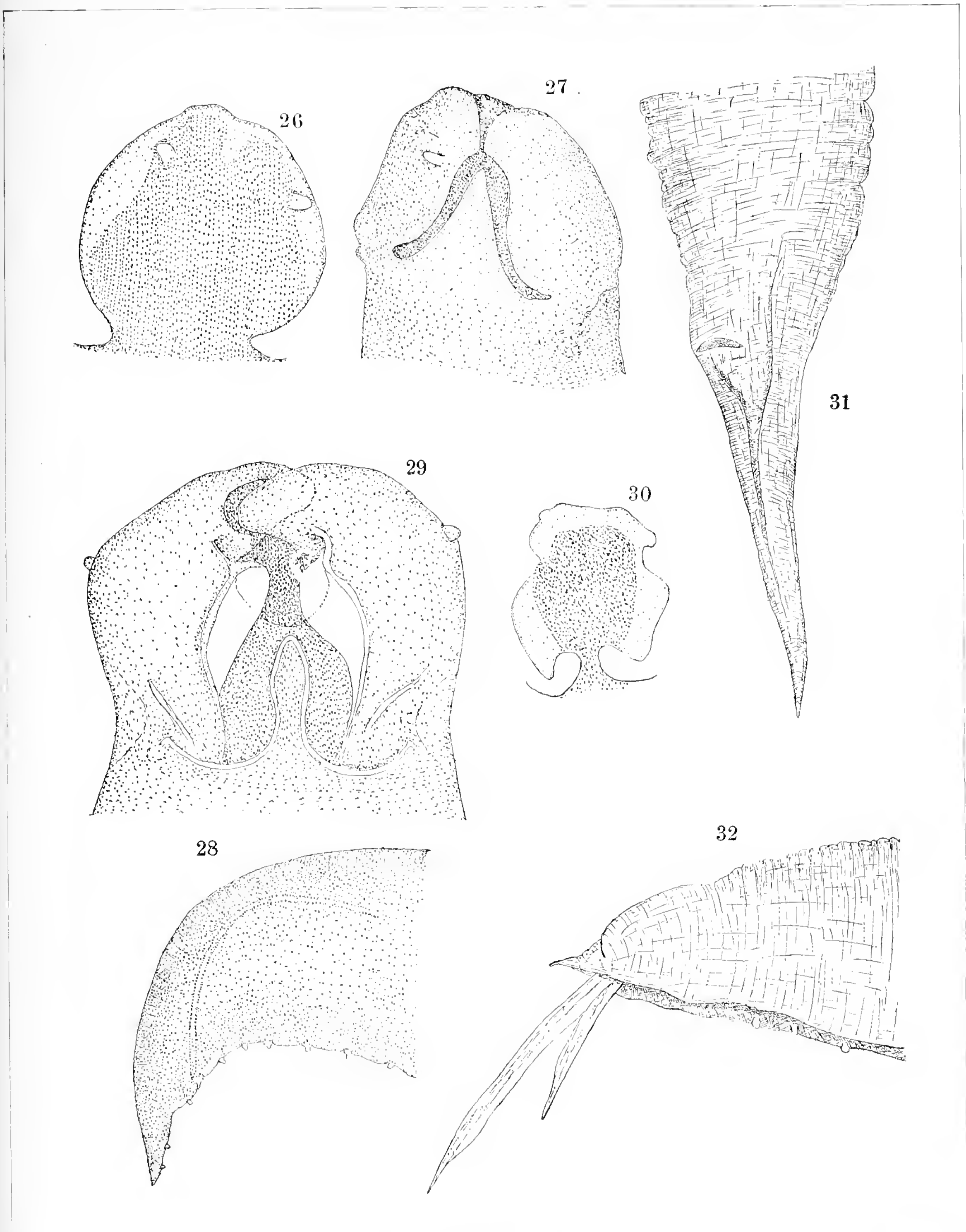
1. Transverse section of dorsal region of young herring (*Clupea harengus*) with cysts containing sporozoa. × 32. *m*, Muscular tissue; *sp*, cysts containing sporozoa; *v*, vertebra.
2. Transverse section showing two small cysts, one of them (*sp.'*) in the midst of a muscle fiber. × 400. *ct*, Connective tissue with sporozoa.
3. Isolated sporozoa, different views and enlargements, life.
4. Piece of intestine of *Pseudopleuronectes americanus*, serous coat covered with cysts due to sporosperms. × 2.
5. Protozoa found in intestinal canal of *Dasyatis centrura*. × 700.



6. *Echinorhynchus* sp. (*a*), from *Lopholatilus chamæleonticeps*. × 46.
7. Proboscis of same. × 180.
8. *Echinorhynchus* sp. (*b*), from same host. × 65.
9. Proboscis of same, near apex. × 400.
10. Proboscis of same, near base. × 400.
11. *Echinorhynchus fusiformis* Zeder (?), from *Opsanus tau*. × 65. *a*, Hooks of same. × 400.
12. *Echinorhynchus proteus* Westrumb, from *Cynoscion regalis*, longitudinal section of head and neck perforating intestinal wall of host. The mucous membrane (*mm*) is continuous over the head of the parasite. × 20.
13. Section passing somewhat diagonally through neck of another parasite, also penetrating intestinal wall of same host. × 65. *m*, Muscular layer; *mm*, mucous membrane.

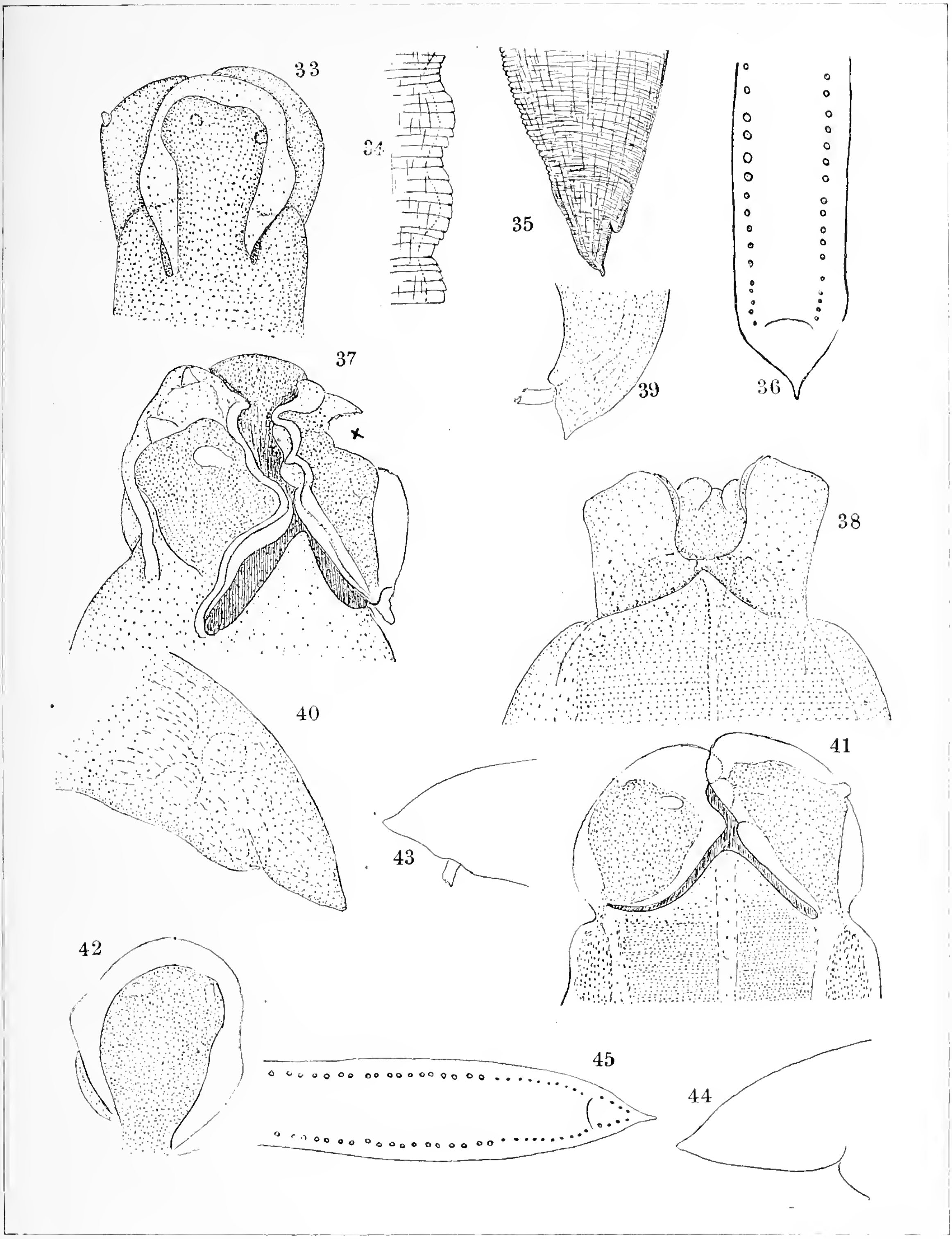


14. *Ascaris rotundata* Rudolphi, from *Raja crinacea*. Side view of head. × 300.
15. Another view of same. × 400.
16. Front view of different specimen from above. × 400.
17. Posterior end of female. × 65.
18. Posterior end of male. × 65.
19. *Ascaris brevicapitata* sp. nov., from *Galeocerdo tigrinus*. Ventral view of head. × 300.
20. Upper lip of same. × 300.
21. Side view of posterior end. × 300.
22. Diagram showing arrangement of anal papillæ so far as could be made out.
23. *Ascaris linstowi* sp. nov. Male and female from *Nematonurus goodei*. × 2.
24. Ventral view of head of female. × 100.
25. Diagram showing arrangement of anal papillæ.

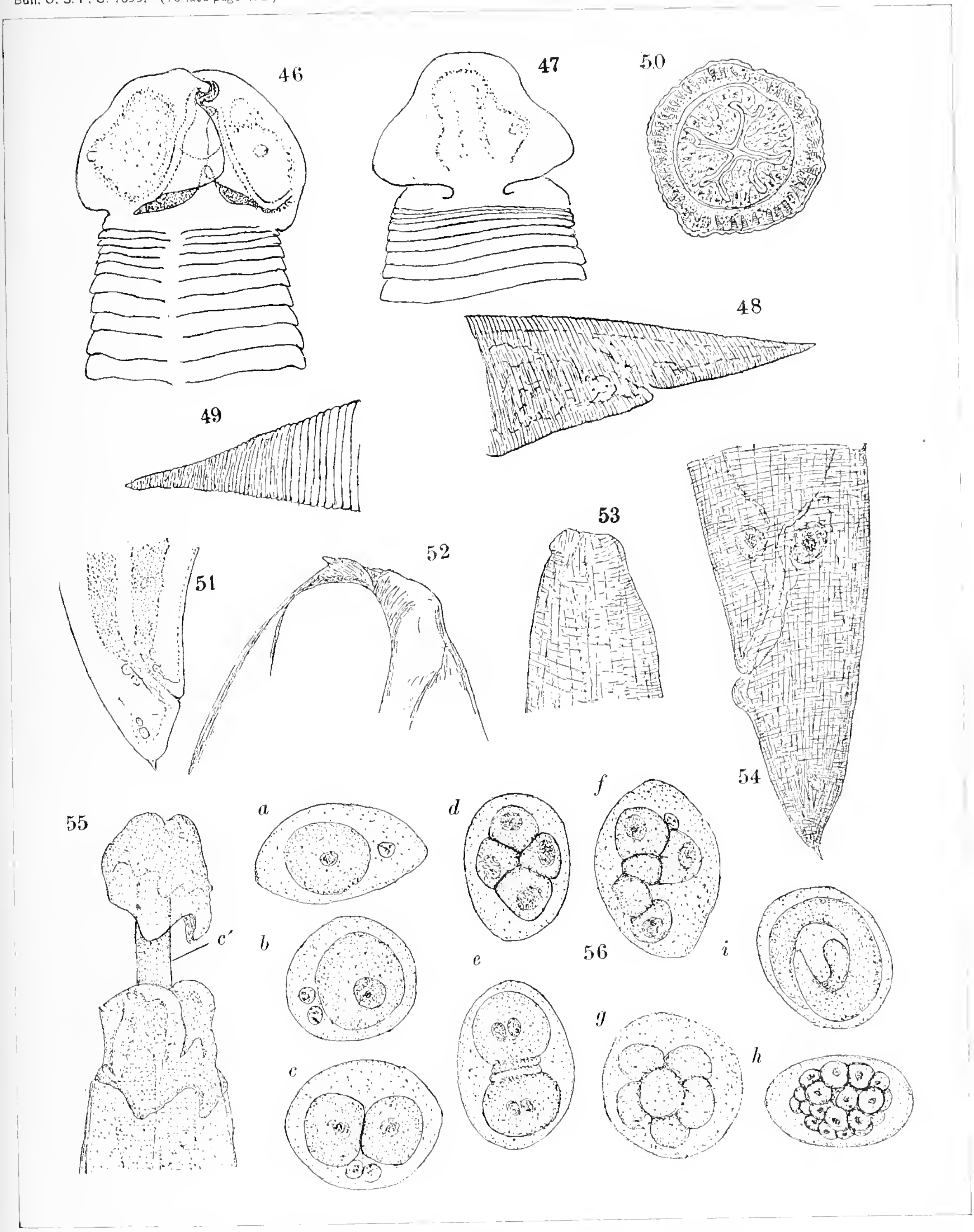


26. *Ascaris linstowi* sp. nov., continued. Upper lip. × 300.
27. Ventral view of head of male. × 300.
28. Lateral view of tail of male. × 65.

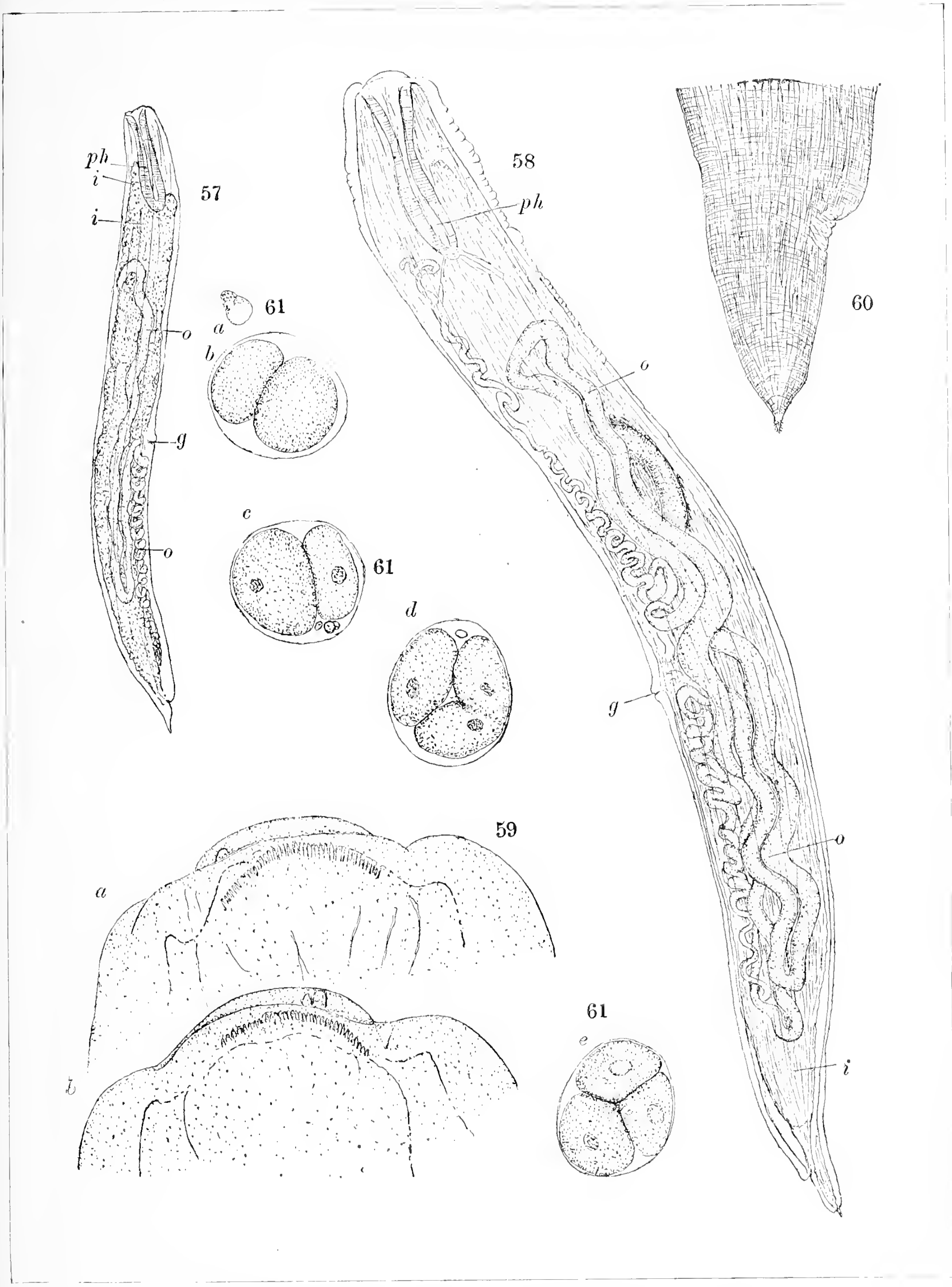
29. *Ascaris incurva* Rudolphi, from *Xiphias gladius*. Ventral view of head. × 300.
30. Upper lip of same. × 300.
31. Nearly ventral view of tail of female. × 40.
32. Tail of male, lateral view. × 65.



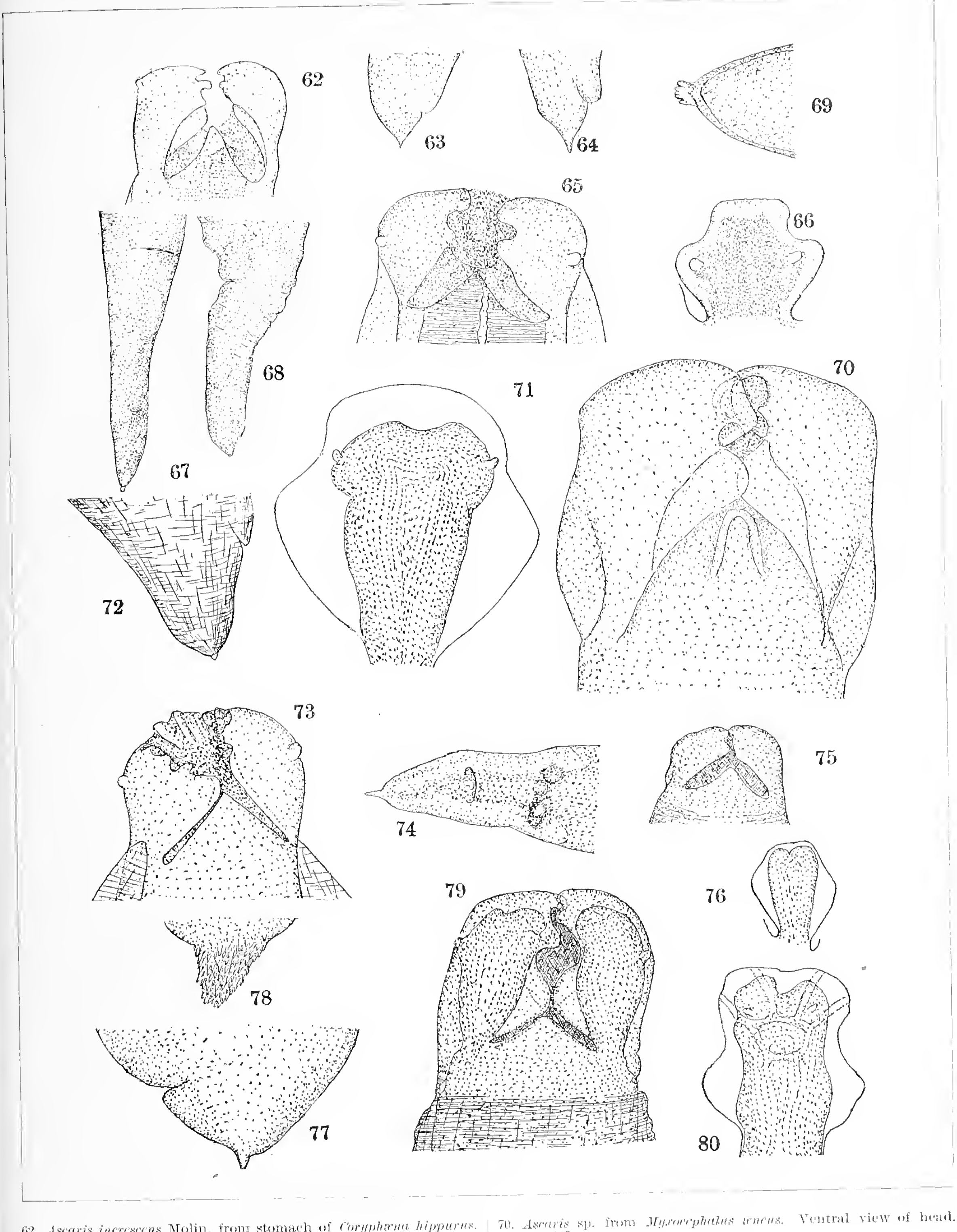
33. *Ascaris neglecta* Leidy, from *Chilomycterus schœpfi*. Head with upper lip. × 300.
34. Cuticle, optical section. × 400.
35. Lateral view of posterior end. × 65.
36. Plan of anal papillæ so far as made out.
37. *Ascaris* sp. from *Sarda sarda*. Ventral view of head of male. × 400. Cuticle missing at x.
38. Jaws of specimen from which the cuticle was entirely absent. × 300.
39. Lateral view of tail of male, spicules broken. × 65.
40. Lateral view of tail of female. × 65.
41. *Ascaris* sp. from *Pomolobus mediocris*. Ventral view of head. × 300.
42. Upper lip of male. × 300.
43. Lateral view of tail of male. × 100.
44. Same of female. × 100.
45. Plan of anal papillæ.



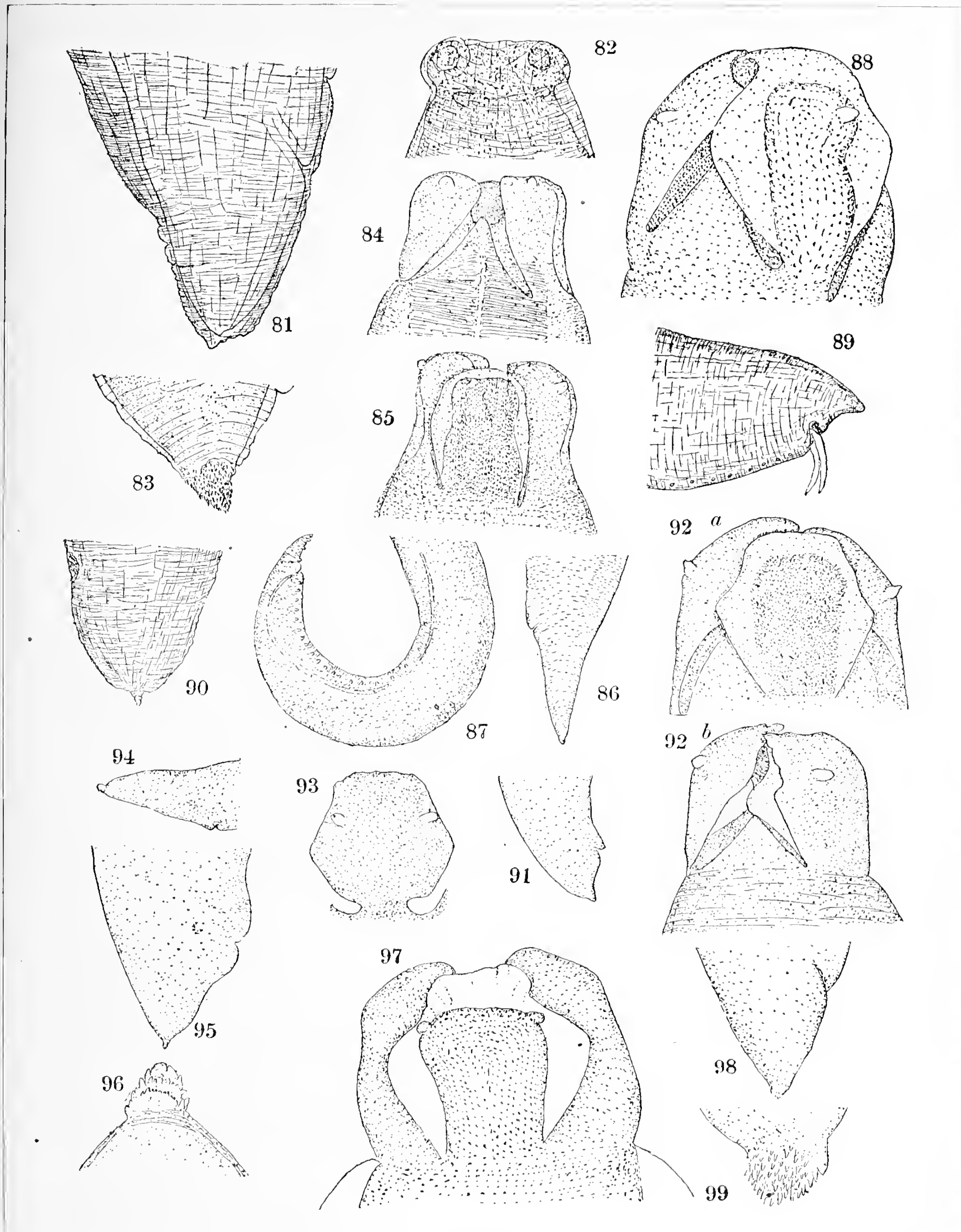
46. *Ascaris inquies* sp. nov., from *Rachycentron canadus*. Ventral view of head. × 220.
47. Upper lip. × 220.
48. Posterior end, lateral view. × 65.
49. Posterior extremity. × 220.
50. Transverse section through anterior end. × 100.
51. Immature nematode encapsuled on intestine of *Mola mola*. Head. × 700.
52. Posterior end, lateral view. × 100.
53. Immature nematode (*Ascaris*) from *Urophycis chuss*. Lateral view of head. × 160.
54. Lateral view of posterior end. × 160.
55. *Ascaris habena* Linton, young, from *Opsanus tau*. Anterior end showing the embryonic cuticle in the act of sloughing off. Sketched from life. Note that the cuticle of the pharynx *c′* is also separating. × 300.
56. *a–i*, Ova showing different stages of development, life. Forms like *c* and *f* noticed on different occasions. The embryo *i* was in an ovum which had been kept 2 days in sea water.



57. *Ascaris* (?) sp. from *Paralichthys dentatus*. Lateral view of female; life. *g*, Genital aperture; *i*, intestine; *o*, ovary; *ph*, pharynx. × 44.
58. Same from opposite side. × 68.
59. Two views (*a* and *b*) of head. × 400.
60. Posterior end, lateral view. × 400.
61. *a*, Spermatozoon; *b–e*, ova in different stages of segmentation; life.



62. *Ascaris increscens* Molin, from stomach of *Coryphæna hippurus*. Ventral view of head of male. × 168.
63. Tail of same, spicules retracted. × 45.
64. Tail of specimen from *Lophius piscatorius*. × 45.
65. *Ascaris* sp. from *Stenotomus chrysops*. Ventral view of head. × 170.
66. Upper lip of same. × 170.
67. Posterior end, ventral view. × 45.
68. Posterior end, lateral view. × 45.
69. Tip of posterior end, optical section. × 210.
70. *Ascaris* sp. from *Myxocephalus æneus*. Ventral view of head. × 225.
71. Upper lip. × 225.
72. Posterior end, lateral view. × 225.
73. *Ascaris* sp. from *Scomber scombrus*. × 225.
74. Posterior end, ventral view. × 75.
75. *Ascaris* sp. from *Phycis tenuis*. × 50.
76. Upper lip. × 50.
77. Posterior end, lateral view. × 50.
78. Extreme tip of tail. × 225.
79. *Ascaris* sp. from *Sciænops ocellatus*. Ventral view of head. × 75.
80. Upper lip. × 75.

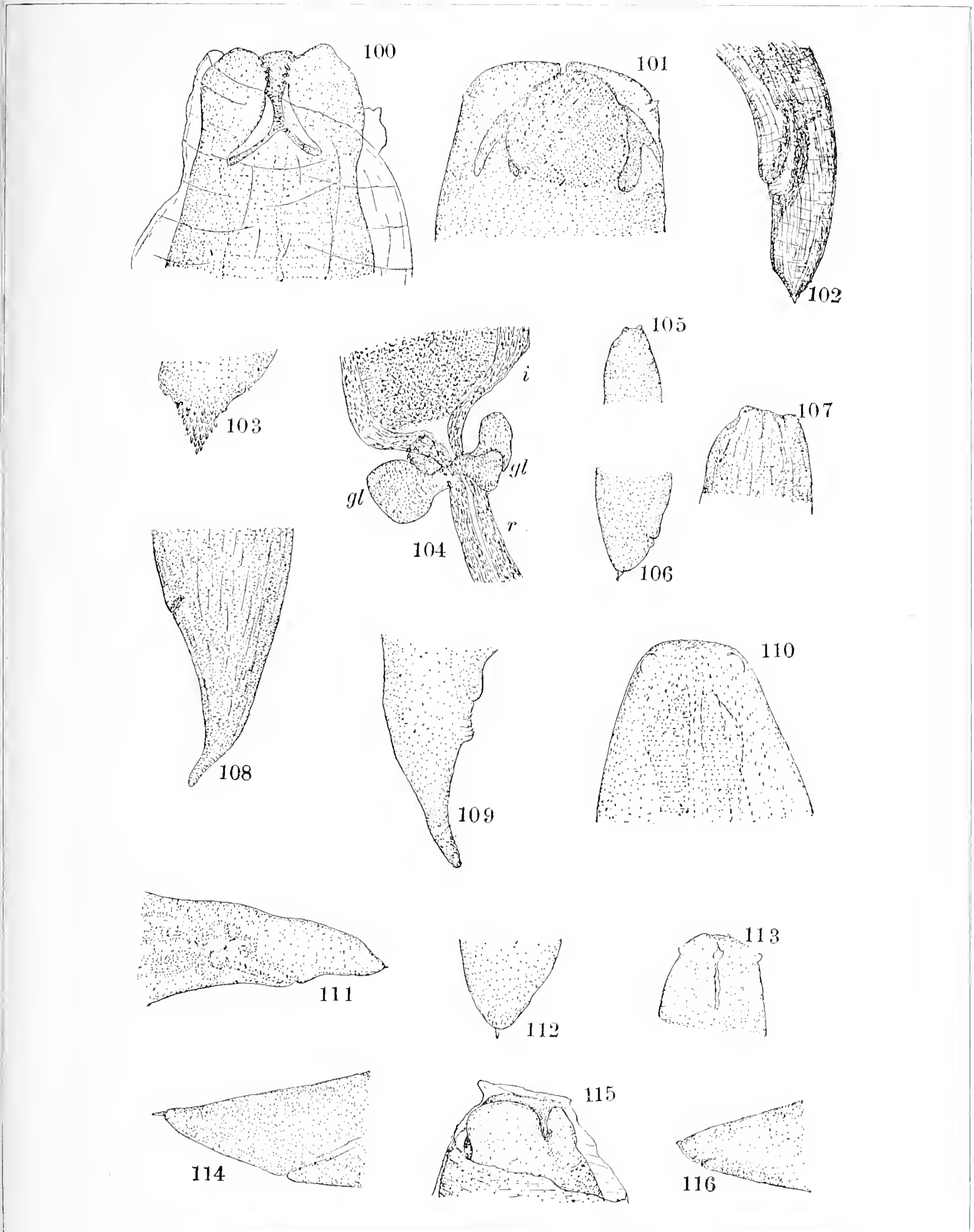


81. *Ascaris* sp. from *Sciænops ocellatus*, continued. Posterior end, lateral view. × 50.
82. Head of young specimen. × 225.
83. Extreme tip of tail highly magnified.
84. *Ascaris* sp. from *Cottunculus thomsonii*. Head of female. × 170.
85. Upper lip. × 170.
86. Posterio end, lateral view. × 27.
87. Posterior end of male, lateral view. × 22.
88. *Ascaris* sp. from *Pseudopleuronectes americanus*. View of head, highly magnified.
89. Posterior view of male, lateral view. × 50.
90. *Ascaris* sp. from *Mustelus canis*. Posterior end, lateral view. × 168.
91. *Ascaris* sp. from *Hemitripterus americanus*. Posterior end of female. × 60.

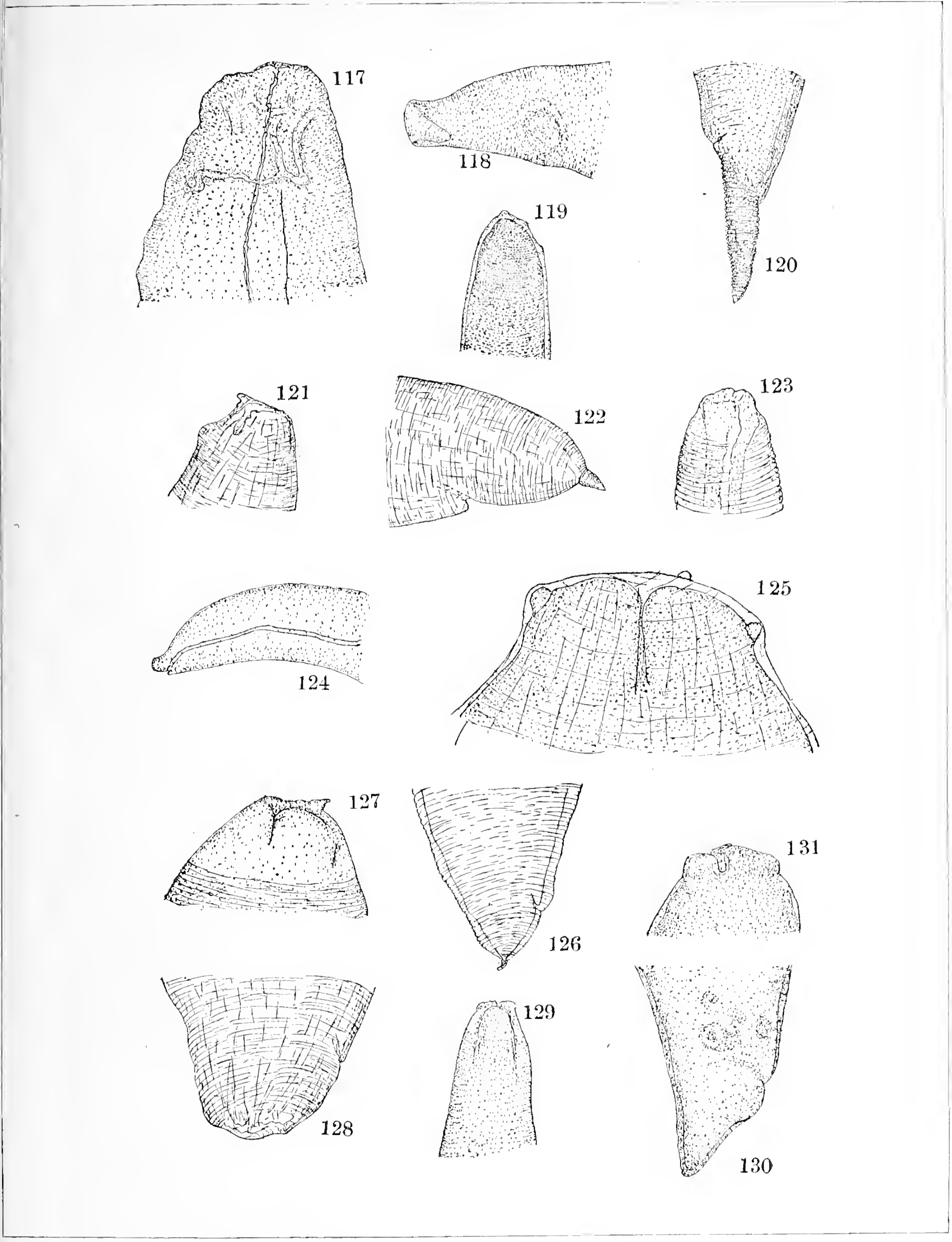
92*a*. Dorsal view of head. × 180.

92*b*. Ventral view of head. × 180.

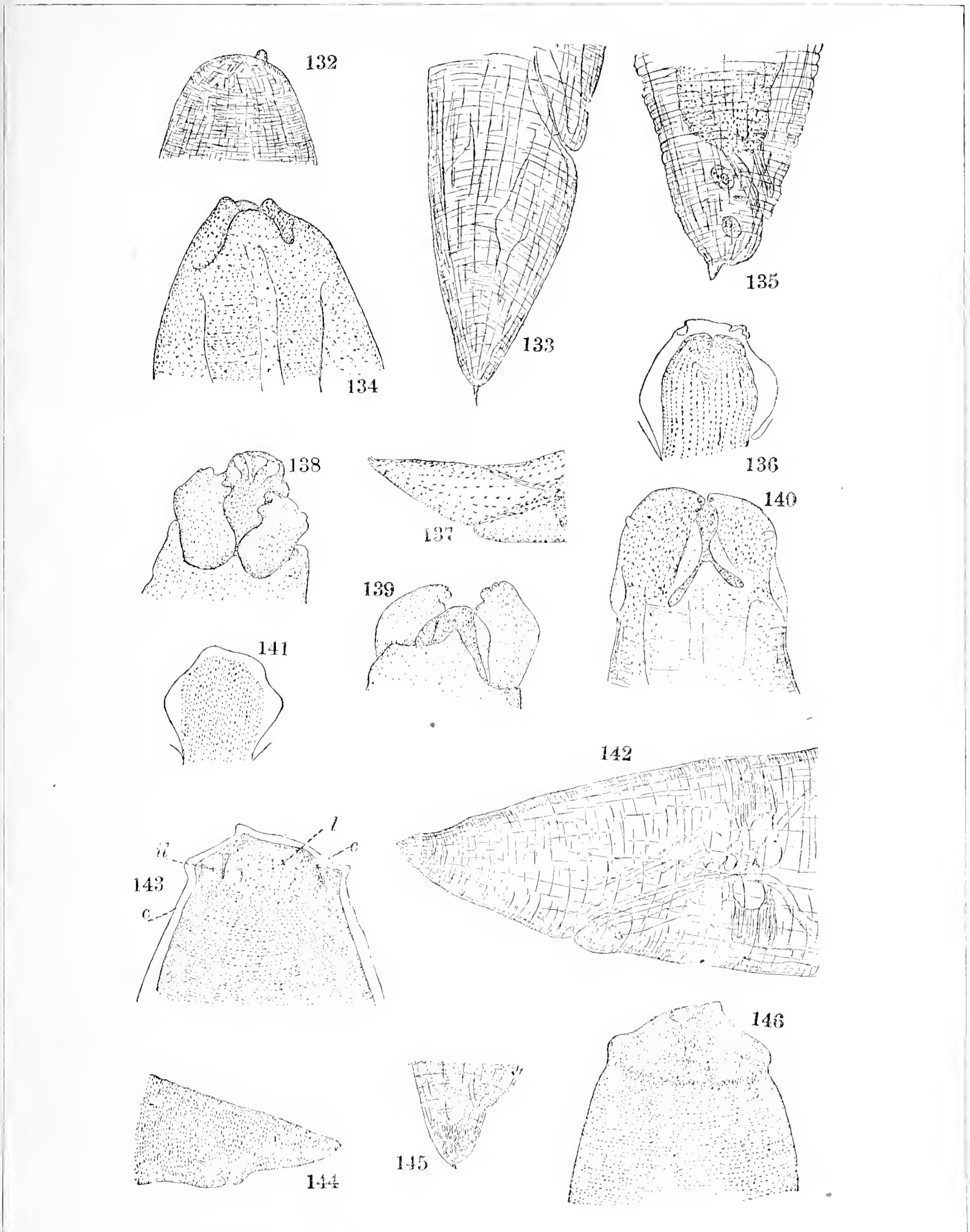
93. Upper lip of same. × 180.
94. Posterior end of small specimen. × 60.
95. *Ascaris* sp. (probably same species as foregoing) from *Glyptocephalus cynoglossus*. Posterior end. × 42.
96. Extreme tip of tail. × 210.
97. *Ascaris* sp. from *Microgadus tomcod*. Dorsal view of head. × 225.
98. Posterior end, lateral view. × 75.
99. Extreme tip of same. × 300.



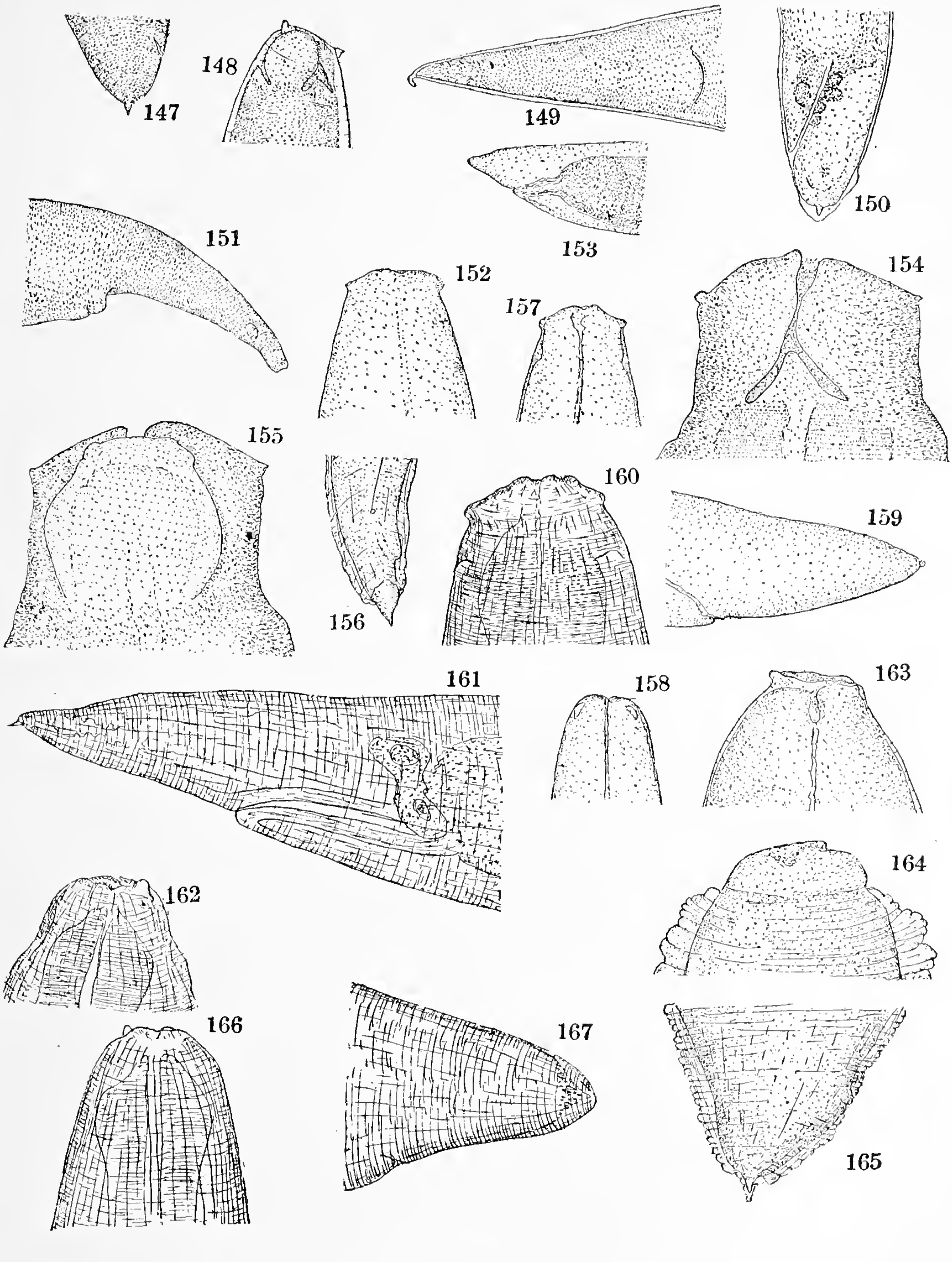
100. *Ascaris* sp. from *Pomatomus saltatrix*. Lateral view of head. × 225.
101. Dorsal view of head. × 225.
102. Posterior end, lateral view. × 50.
103. Extreme posterior tip. × 225.
104. Anal glands, optical section. × 225. *i*, Intestine; *gl*, glands; *r*, rectum.
105. Head of younger specimen than the foregoing. × 50.
106. Posterior end. × 50.
107. *Ascaris* sp. from *Cynoscion regalis*. Head. × 225.
108. Posterior end. × 225.
109. Posterior end of a specimen from another lot. × 150.
110. *Ascaris* sp. from *Stenotomus chrysops*. Head. × 225.
111. Posterior end of same. × 75.
112. Extreme posterior end. × 225.
113. Head of specimen from another lot. × 170.
114. Posterior end. × 170.
115. Head of another specimen, removed from capsule on peritoneum. The embryonic cuticle is broken, showing the rudimentary jaws. × 225.
116. Posterior end. × 75.



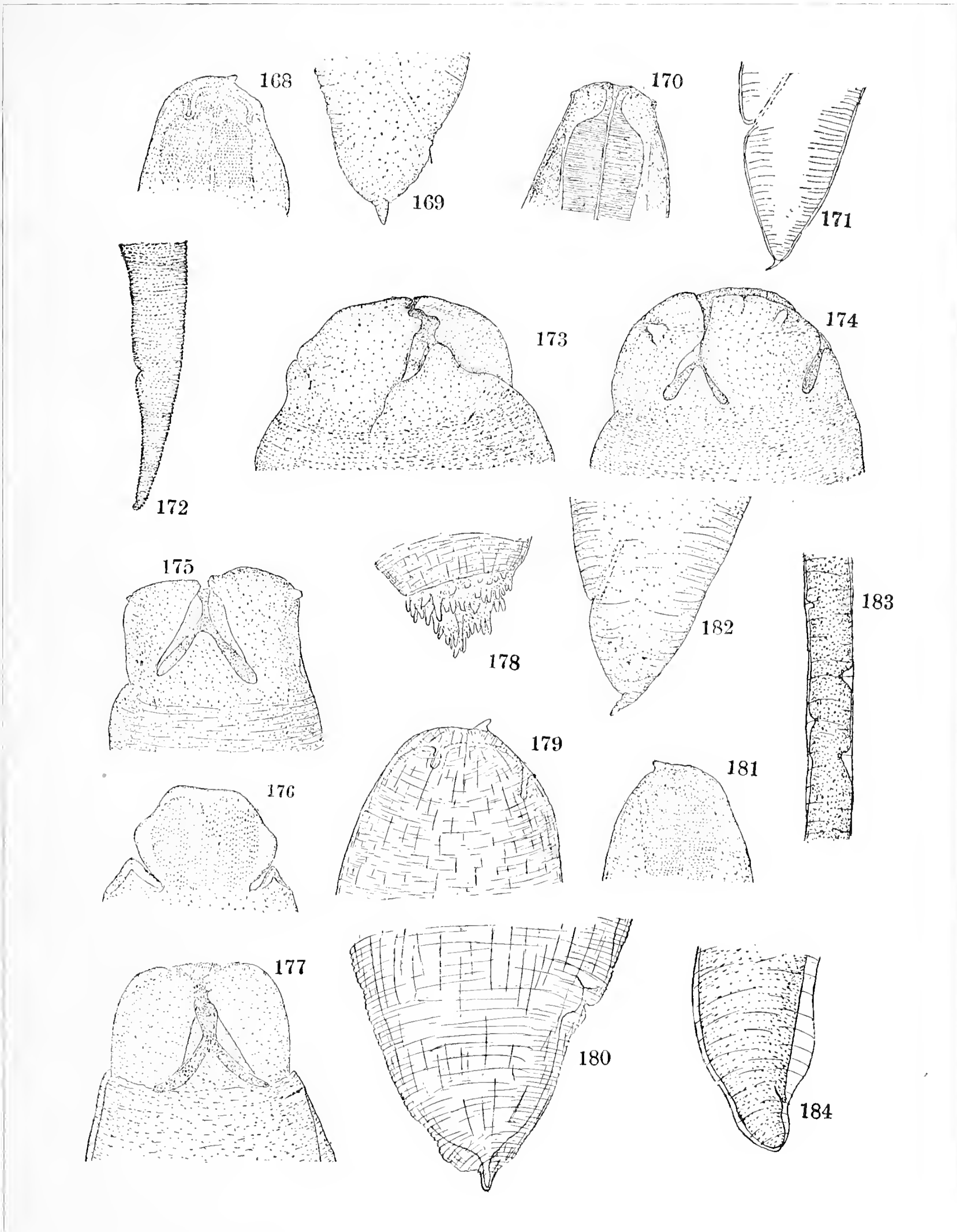
117. *Immature nematodes* (*Ascaris*) from *Stenotomus chrysops*, continued. Head of specimen from Charleston, S. C. × 170.
118. Posterior end. × 170.
119. Anterior end of specimen from another lot. × 225.
120. Posterior end of same. × 225.
121. *Ascaris* sp., immature, from *Lagocephalus lævigatus*. Head. × 225.
122. Posterior end. × 225.
123. *Ascaris* sp., immature, from *Lopholatilus chamæleonticeps*. Head. × 150.
124. Posterior end. × 150.
125. *Ascaris* sp. from *Anguilla chrysypa*. Head. × 225.
126. Posterior end. × 150.
127. *Ascaris* sp., immature, from *Carcharias littoralis*. Head. × 225.
128. Posterior end, lateral view. × 225.
129. Head of specimen from another lot. × 30.
130. Posterior end. × 30.
131. *Ascaris* sp. from *Salmo salar*. Head. × 150.



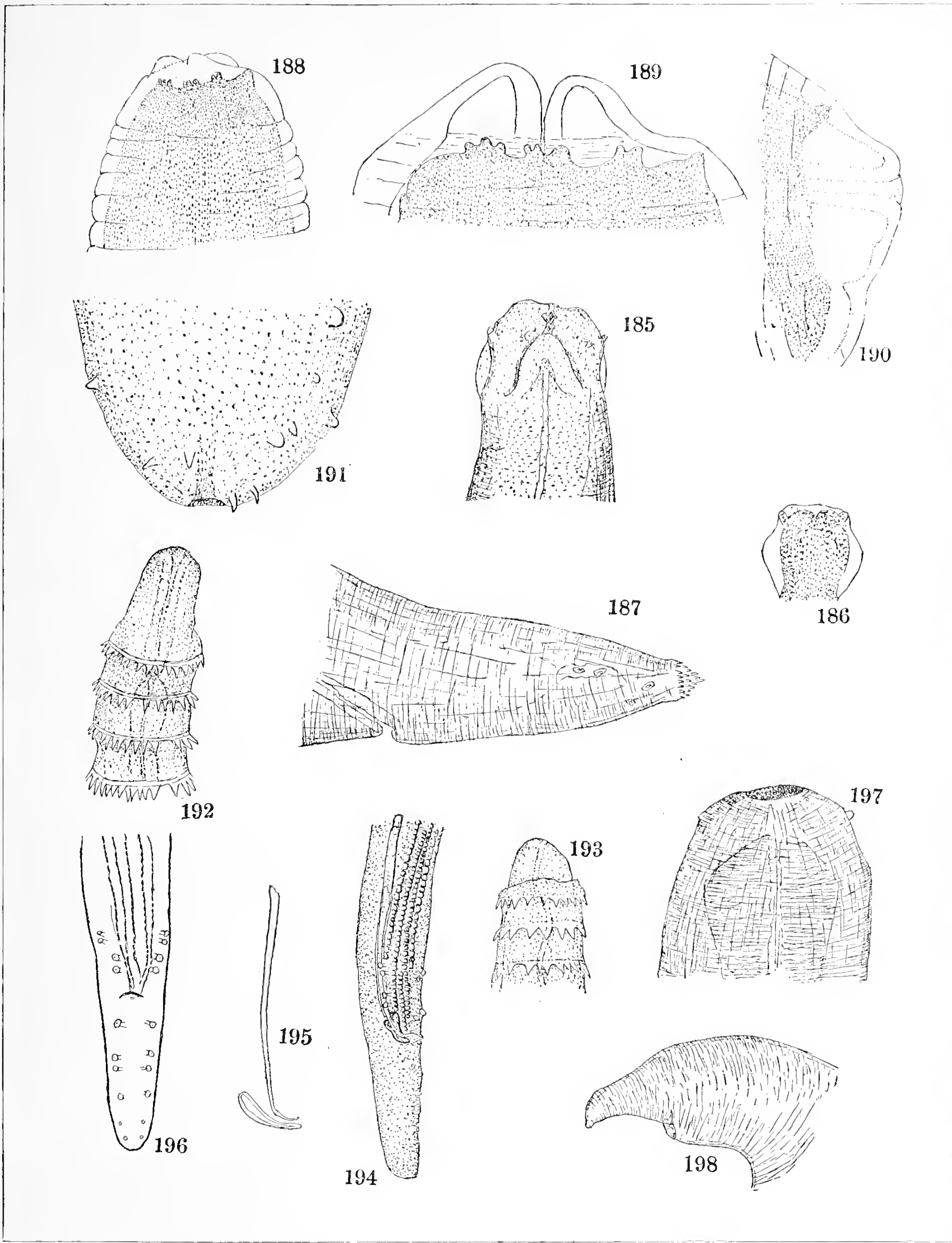
132. *Immature nematode* (*Ascaris*) from *Rhombus triacanthus*. Head. × 225.
133. Posterior end. × 225.
134. *Immature nematode* (*Ascaris*) from *Sciænops ocellatus*. Head. × 225.
135. Posterior end. × 50.
136. Upper lip of older specimen from another lot. × 225.
137. Posterior end. × 50.
138. *Ascaris* sp. from *Alosa sapidissima*. Head, ventral view. × 200.
NOTE.—The specimens in this lot were somewhat distorted, the alcohol having evaporated from them.
139. Another view of head of a different specimen from the foregoing. × 200.
140. *Ascaris* sp. from *Lobotes surinamensis*. Head. × 225.
141. Upper lip. × 225.
142. Posterior end lateral view. × 225.
143. *Ascaris* sp., immature, from *Paralichthys dentatus*. Head. × 225. *c*, Embryonic cuticle; *il*, interlip; *l*, lip.
144. Posterior end, lateral view. × 75.
145. Extreme posterior tip. × 225.
146. Head of specimen from another lot, younger stage. × 225.



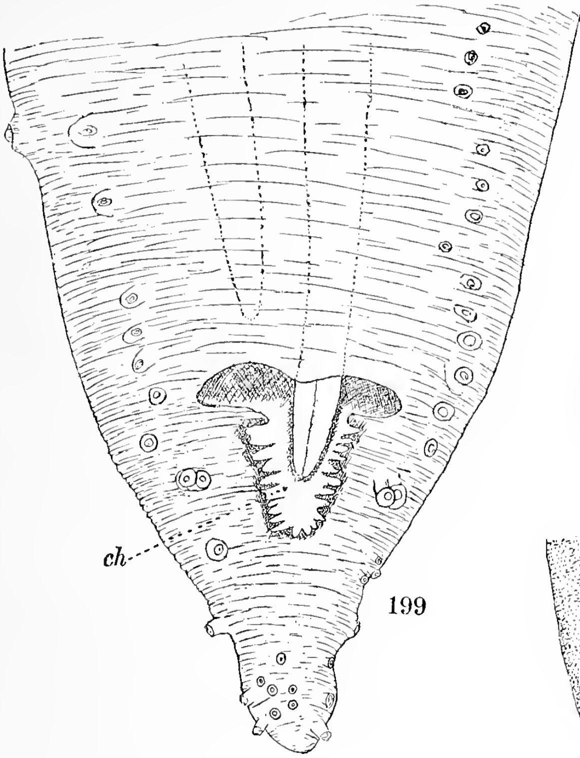
147. *Ascaris* sp. from *Paralichthys dentatus*, continued. Posterior end of specimen shown in figure 146. × 75.
148. Head of specimen from another lot. × 225.
149. Posterior end of same. × 225.
150. Posterior end of specimen from another lot. × 75.
151. Posterior end of another from a different lot. × 225.
152. *Ascaris* sp., immature, from *Paralichthys oblongus*. Head. × 165.
153. Posterior end, lateral view. × 45.
154. *Ascaris* sp., immature, from *Bothus maculatus*. Lateral view of head. × 210.
155. Dorsal view of head. × 210.
156. Posterior end. × 24.
157. *Ascaris* sp., immature, from *Hemitripterus americanus*. Head. × 150.
158. Head of younger specimen. × 150.
159. Posterior end of same. × 150.
160. *Ascaris* sp. from *Merluccius bilinearis*. Head. × 225.
161. Posterior end. × 130.
162. Head of specimen from another lot. × 225.
163. *Ascaris* sp. from *Antimora viola*. Head. × 170.
164. Head of another specimen. × 170.
165. Posterior end of same. × 170.
166. *Ascaris* sp. from *Phycis tenuis*. Head. × 225.
167. Posterior end. × 225.



168. *Ascaris* sp. from *Menticirrus saxatilis*. Head. × 170.
169. Posterior end. × 170.
170. Head of specimen from another lot. × 170.
171. Posterior end of same. × 170.
172. *Ascaris* sp. from *Scomberomorus maculatus*. Posterior end. × 24.
173. *Ascari* sp. from *Macrourus bairdii*. Head. × 225.
174. Opposite side of head of same specimen. × 225.
175. Head of older specimen from another lot. × 170.
176. Upper lip of same, somewhat foreshortened, × 185.
177. Head of another speeimen from same lot. × 210.
178. Tip of posterior end of same. × 375.
179. *Ascaris* sp. from *Lophius piscatorius*. Head. × 225.
180. Posterior end. × 225.
181. *Ascaris* sp. from *Scomber scombrus*. Head. × 180.
182. Posterior end. × 180.
183. *Ascaris* sp. from *Sphyrna zygæna*. Portion of body. × 60.
184. Posterior end. × 36.



185. *Ascaris*, sp. immature, from *Lophius piscatorius*. Ventral view of head. × 300.
186. Upper lip. × 300.
187. Posterior end, lateral view. × 300.
188. *Filaria rubra* Leidy, from *Centropristes striatus*. Lateral view of head. × 75.
189. Optical section of same. × 200.
190. Opposite side of same. × 200.
191. Posterior end. × 200.
192. *Filaria serrata* sp. nov., from *Phycis tenuis*. Head and anterior end of female. × 300.
193. Head of male. × 300.
194. Posterior end of same, showing longitudinal serrate rows of plates. × 240.
195. Copulatory spines. × 240.
196. Plan of anal papillæ.
197. *Spiroptera pectinifer* sp. nov., from *Sphyrna zygæna*. Head of male. × 300.
198. Posterior end of same, lateral view. × 65.



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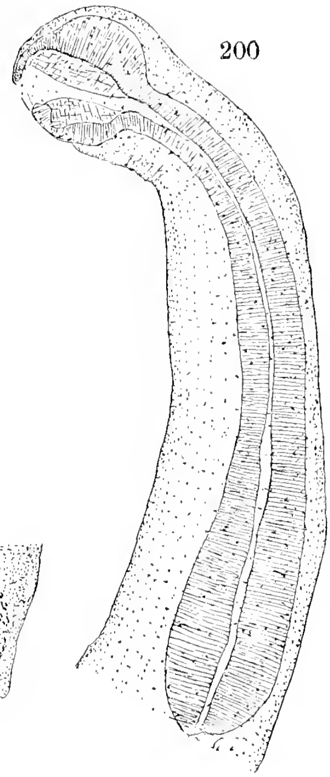

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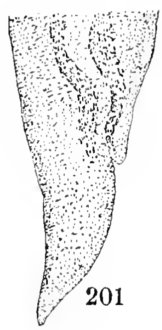

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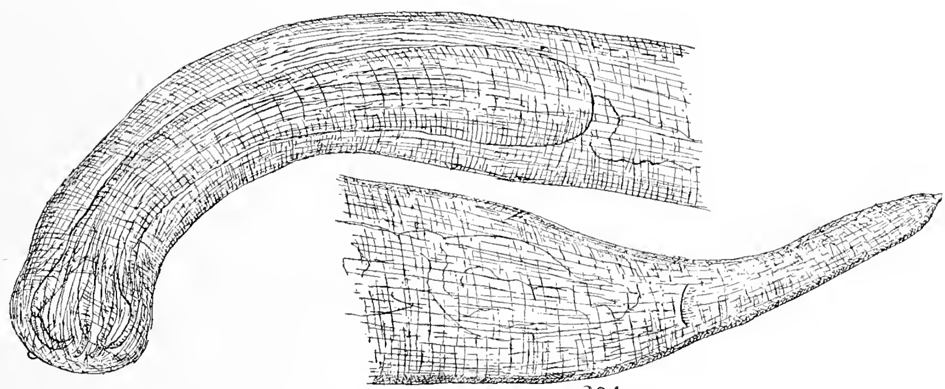

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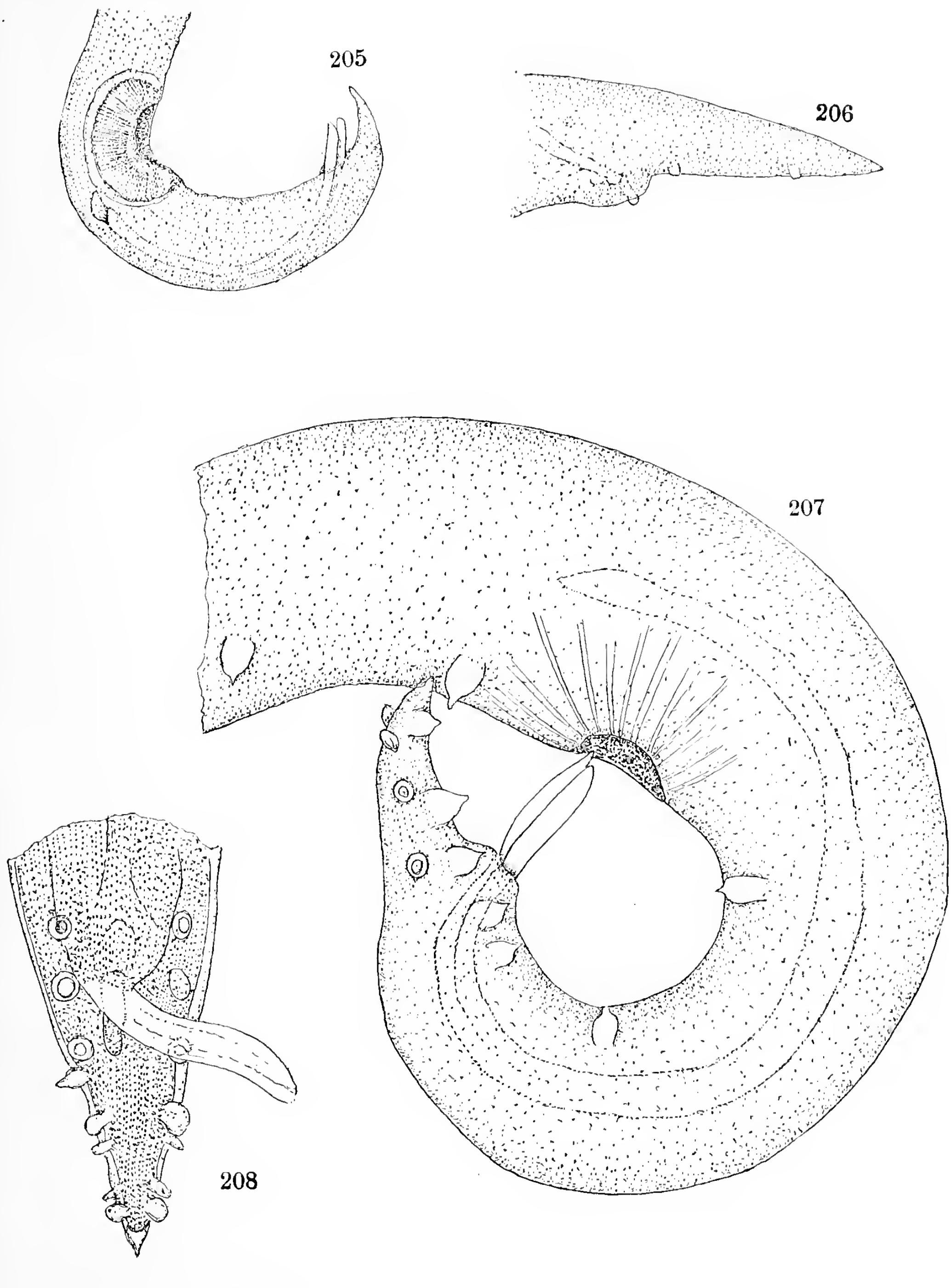
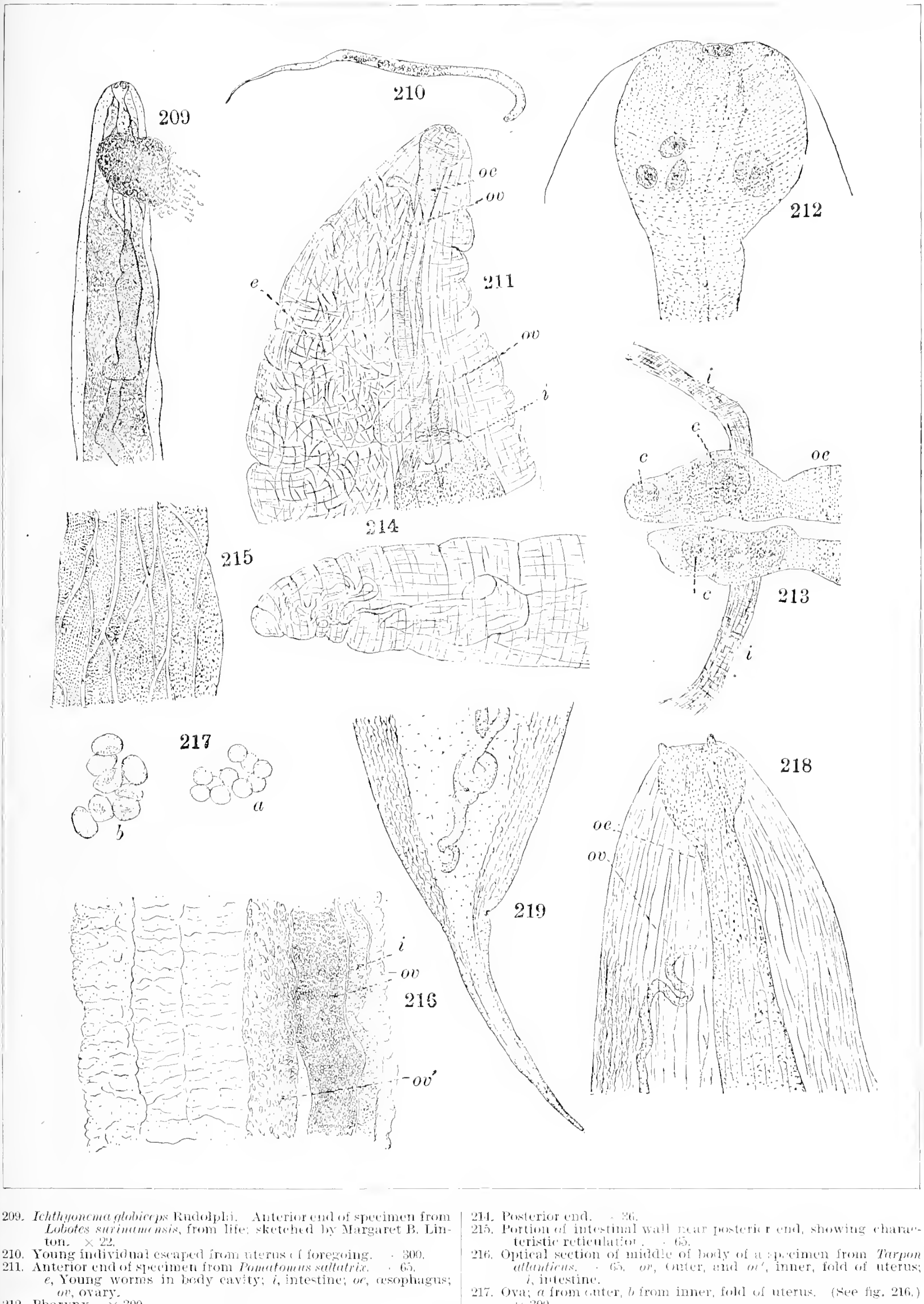
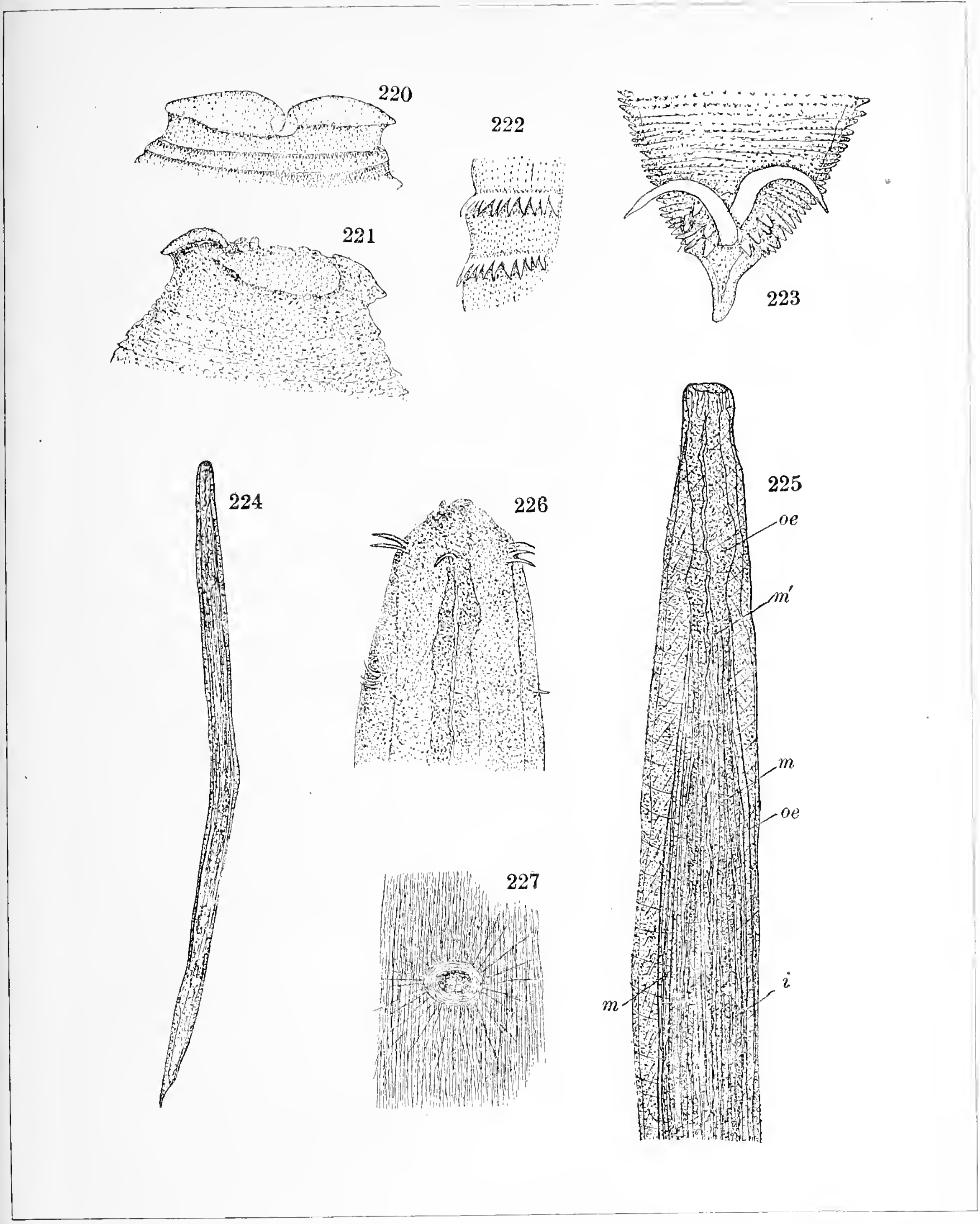
199. *Spiroptera pectinifer* sp. nov., continued. Ventral view of posterior end of male. × 300. *ch*, Chitinous toothed plate.
NOTE.—There were four more groups of three papillæ each seen on the left side anterior to those shown in the figure.
200. *Dacnitis sphærocephala* Dujardin, from *Acipenser sturio*. Anterior end, optical section. × 65.
201. Posterior end. × 65.
202. Embryo sketched in uterus. × 300.
203. *Dacnitis hians* Dujardin, from *Leptocephalus conger*. Lateral view of head, optical section. × 100.
204. Posterior ventral view of same. × 100.



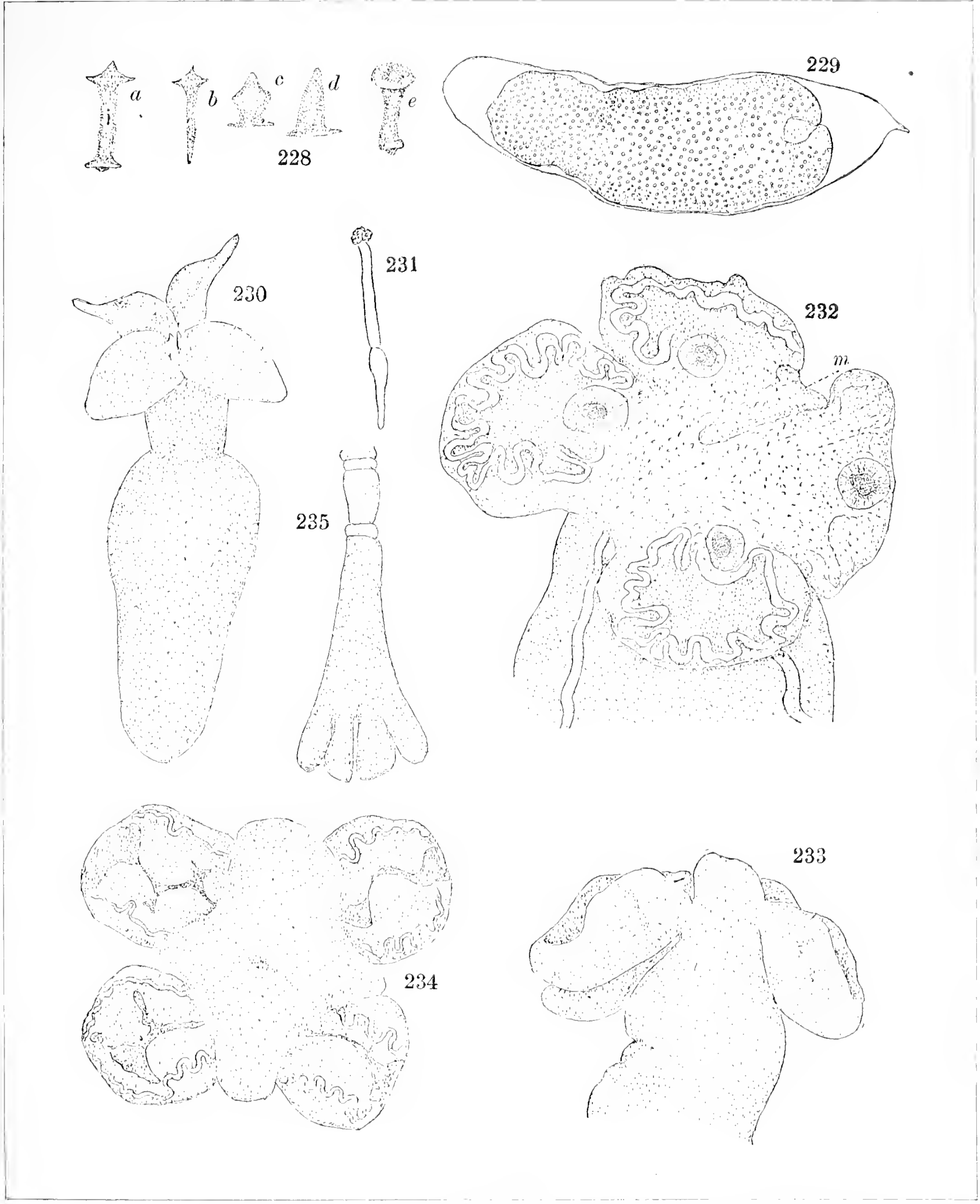
205. *Cucullanus globosus* Zeder, from *Lophius piscatorius*. Posterior end of male. × 65.
206. Lateral view of posterior end of male from *Gadus callarias*. × 200.
207. *Cucullanus* sp. from *Fundulus heteroclitus*. Posterior end of male, lateral view; life. × 300.
208. Ventral view of posterior extremity. × 300.



209. *Ichthyonema globiceps* Rudolphi. Anterior end of specimen from *Lobotes surinamensis*, from life; sketched by Margaret B. Linton. × 22.
210. Young individual escaped from uterus of foregoing. × 300.
211. Anterior end of specimen from *Pomatomus saltatrix*. × 65. *e*, Young worms in body cavity; *i*, intestine; *oe*, œsophagus; *ov*, ovary.
212. Pharynx. × 300.
213. Junction of œsophagus and intestine, optical section. × 300. *c*, *c*, *c*, Cells in wall of œsophageal valve; *i*, wall of intestine; *oe*, œsophagus.
214. Posterior end. × 36.
215. Portion of intestinal wall near posterior end, showing characteristic reticulation. × 65.
216. Optical section of middle of body of a specimen from *Tarpon atlanticus*. × 65. *ov*, Outer, and *ov'*, inner, fold of uterus; *i*, intestine.
217. Ova; *a* from outer, *b* from inner, fold of uterus. (See fig. 216.) × 300.
218. *Ichthyonema* sp. from *Chætodipterus faber*; *oe*, œsophagus; *ov*, ovary. Anterior end. × 100.
219. Posterior end of same. × 100.



220. *Lecanocephalus annulatus* Molin, from *Roccus lineatus.* Head, dorsal view. × 300.
221. Head, ventral view. × 300.
222. Portion of two dentigerous rows, near middle of body. × 300.
223. Posterior end, ventral view, showing spicules and papillæ. × 300.
224. Undetermined nematode from stomach of *Macrourus bairdii.* × 12.
225. Œsophageal region of a specimen with anterior end slightly retracted. × 65. *m′*, Beginning of muscular sheath; *m*, *m*, continuation of same posteriorly; *i*, intestine; *oe*, œsophagus.
226. Anterior end of specimen with spines. × 200.
227. Genital aperture of female. × 300.



228. Cestode larva from intestine of *Decapterus macarellus*; *a* to *d*, sketched from life; *e*, alcoholic. These different forms were assumed by the larva in rapid succession, and by such contractions a progressive movement was effected.
The top of the figure in each case is the anterior end.

229. Blastocyst in cyst from body cavity of *Clupea harengus*. *Rhynchobothrium* sp. × 20.

230. Larval cestode from a squid (*Loligo pealii*) in stomach of *Cynoscion regalis*; life. × 65.
At the base of each petal-like bothrium there is a short conical process, sharp and hooklike, but of dense striated structure, like the hooks of *Thysanocephalum*. Beside each of these processes there is a circular organ like an auxiliary acetabulum, not seen in the living specimen, but visible when mounted in glycerine.

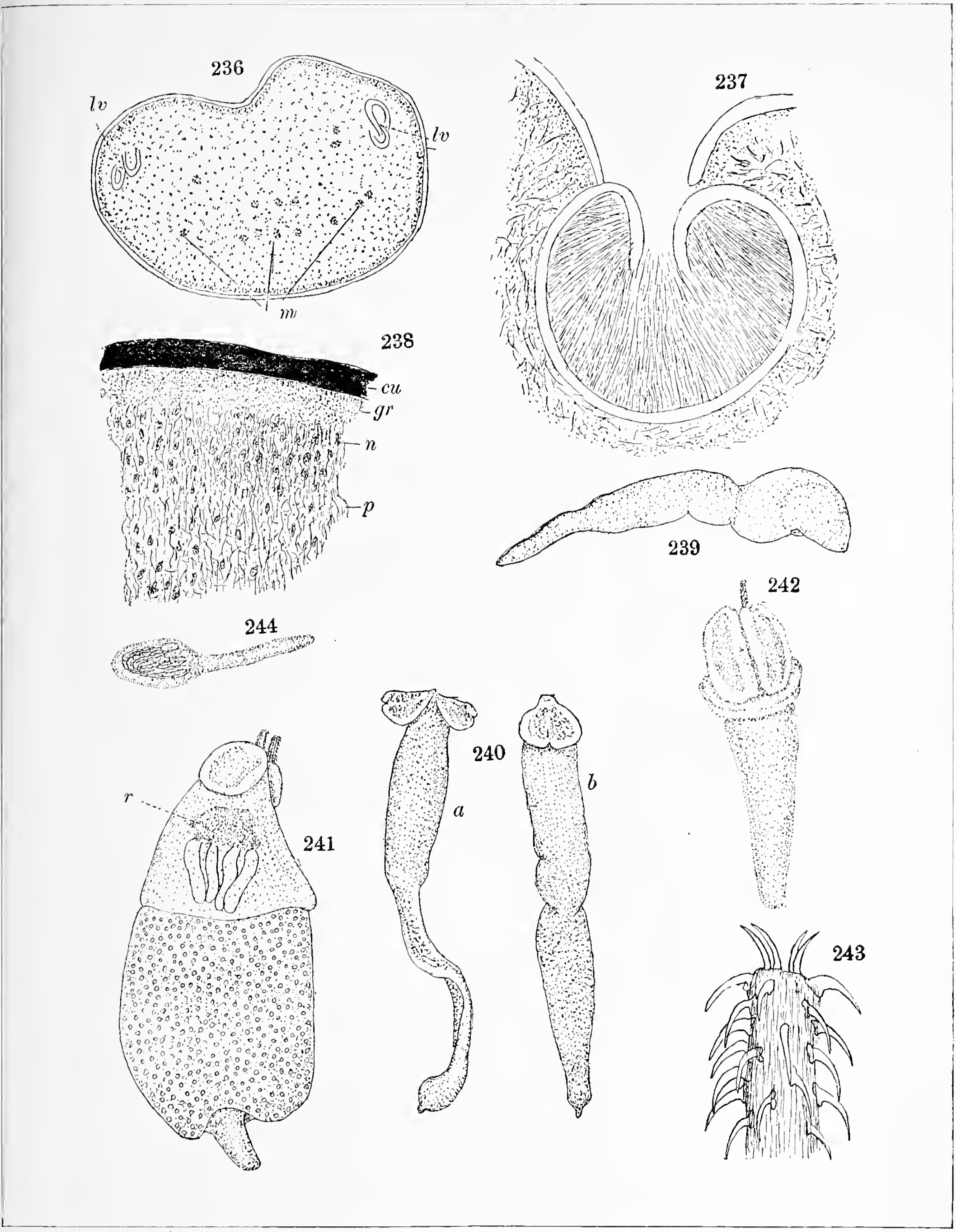
231. *Phyllobothrium* sp. from intestine of *Merluccius bilinearis*; life. × 1.

232. Head, much enlarged. *m*, Myzorhynchus.

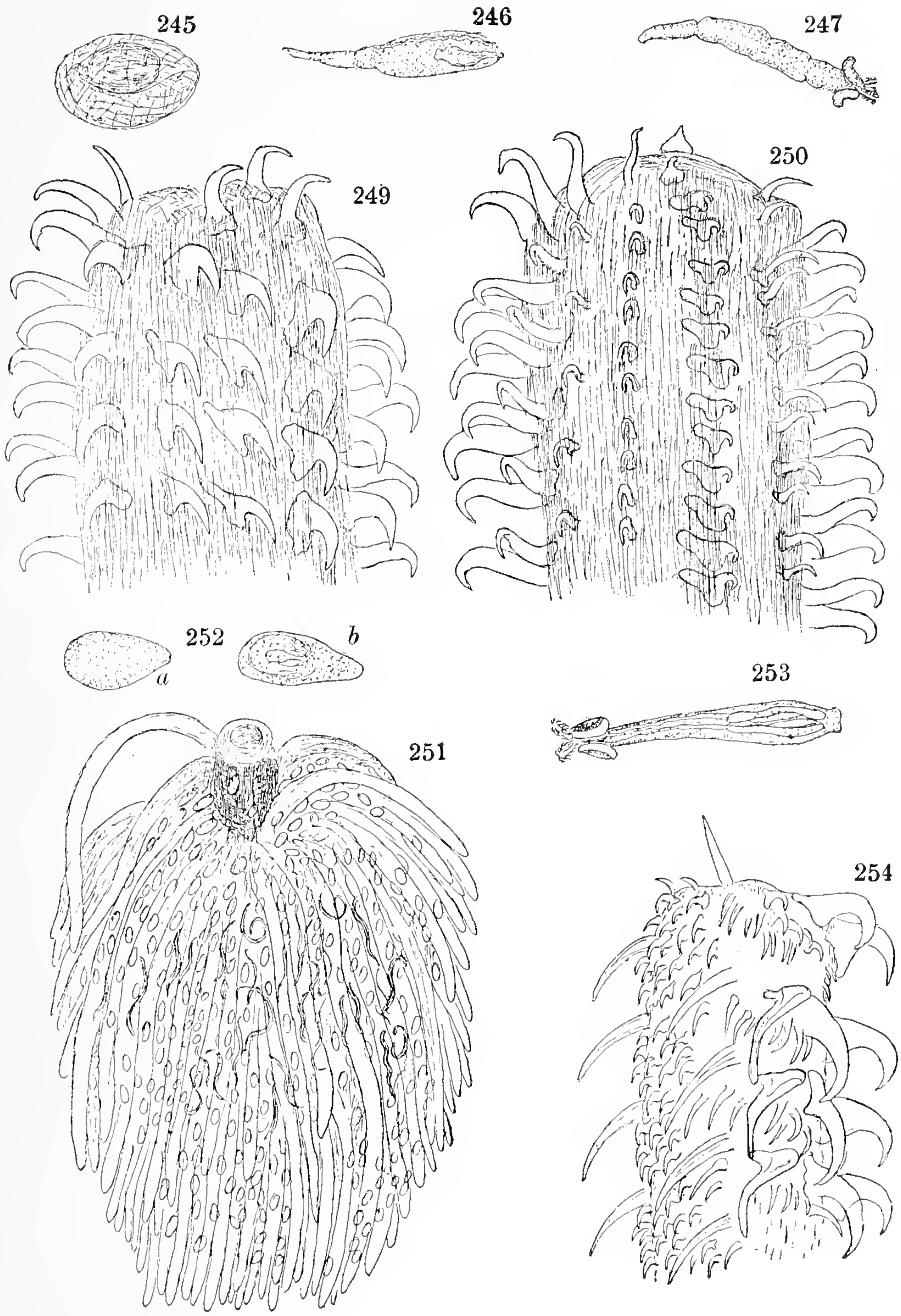
233. Scolex of a cestode, which is probably a new genus, from intestine of *Lopholatilus chamæleonticeps*; alcoholic. × 50.

234. Front view of same. × 70. (See also figs. 236–238.)

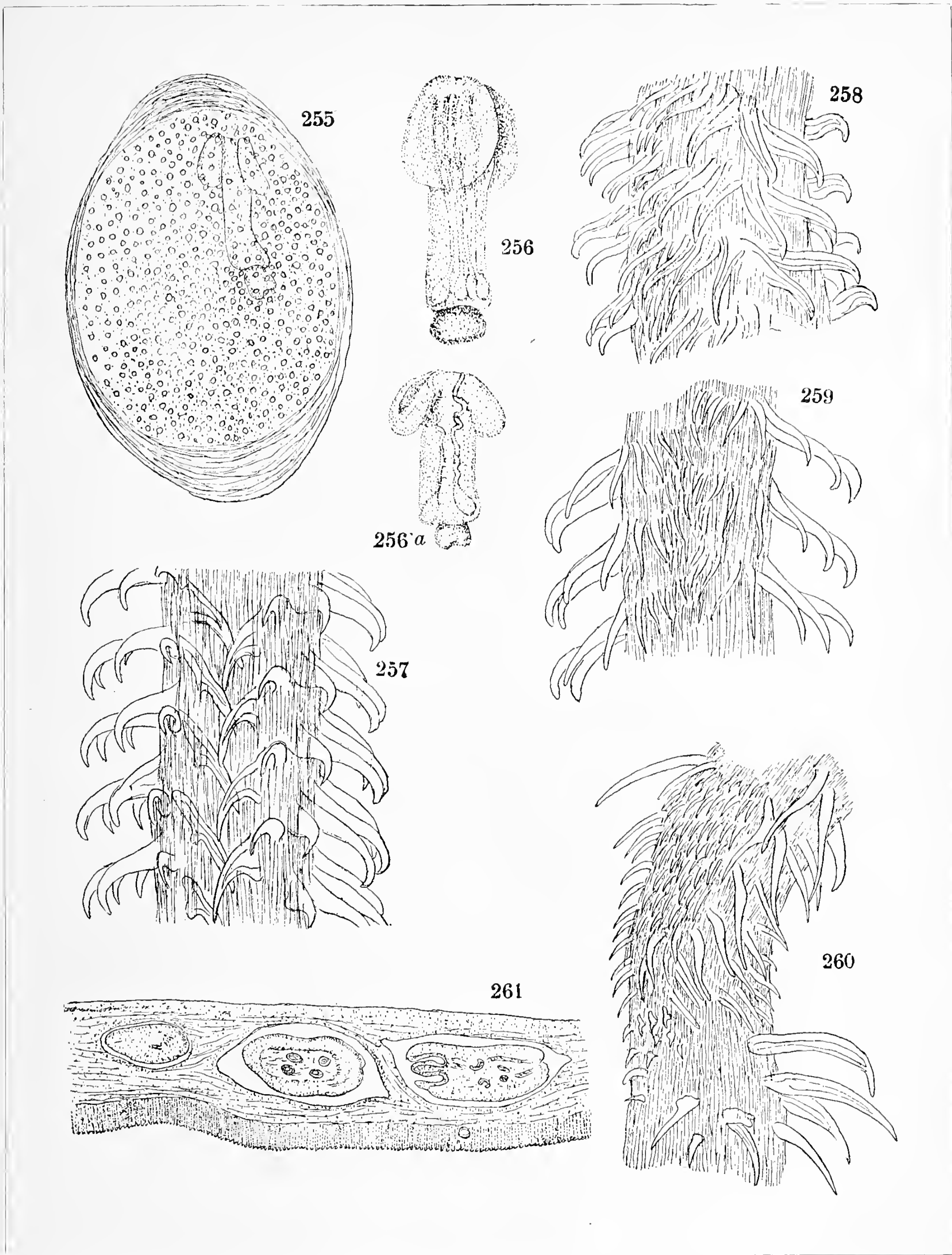
235. *Crossobothrium laciniatum* Linton, from *Carcharias littoralis*. Abnormal segment of young strobile. × 50.



236. New cestode from *Lopholatilus chamæleonticeps*, continued. Section of neck nearly transverse. × 70. *m*, Coarse longitudinal muscles; *lv*, lateral vessels.
237. Section showing portion of anterior disc with its acetabulum. × 400.
238. Section showing structure of body wall. *cu*, Structureless cuticle, not stained; *gr*, granular layer, *n*, nuclear layer; *p*, parenchyma, the nuclei are stained, the fibers unstained. × 700.
239. Blastocyst, probably *Rhynchobothrium speciosum* from *Coryphæna hippurus;* life. × 2.
240, *a* and *b*. Two views of larva liberated from 115. × 6.
241. *Rhynchobothrium tumidulum* Linton; scolex from intestine of *Opsanus tau;* life. *r*, Red pigment patch. × 65.
242. *Tetrarhynchus robustus* Linton; scolex from intestine of *Isurus dekayi;* life. × 22.
243. *Tetrarhynchus bisulcatus* Linton, from *Decapterus macarellus*. Proboscis. × 700.
244. *Rhynchobothrium bulbifer* Linton, from cyst in muscles of back of *Scomber scombrus*. × 15.



245. *Rhynchobothrium* sp. Cyst from beneath serous coat of intestine of *Mola mola*; life. × 1.
246. Blastocyst liberated from cyst. × 1.
247, 248. Two views of larva from blastocyst.
249, 250. Opposite sides of proboscis near apex. × 300.
251. *Rhynchobothrium* sp. Pyloric cæca of *Merluccius bilinearis* with cysts and immature nematodes on serous coat. × 2.
252, *a* and *b*. Cysts, the latter slightly compressed to show the contained embryo. × 4.
253. Embryo liberated from blastocyst. × 18.
254. Proboscis of same. × 400.



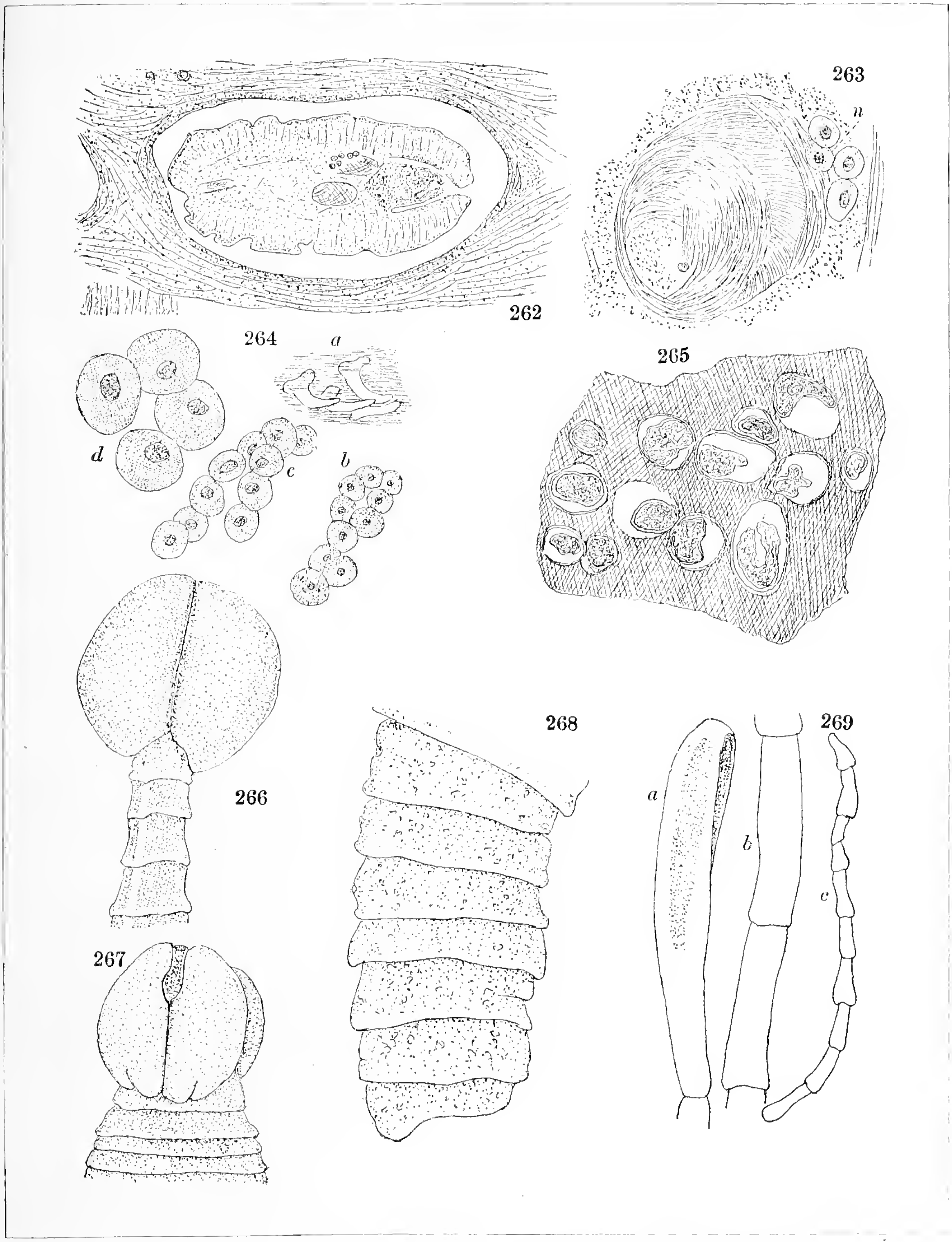
255. *Rhynchobothrium* sp. Cyst from muscles of *Rhombus triacanthus*, compressed to show blastocyst and contained embryo; life. × 100. (See also fig. 265.)

256, 256*a*. Two views of an embryo. × 300.

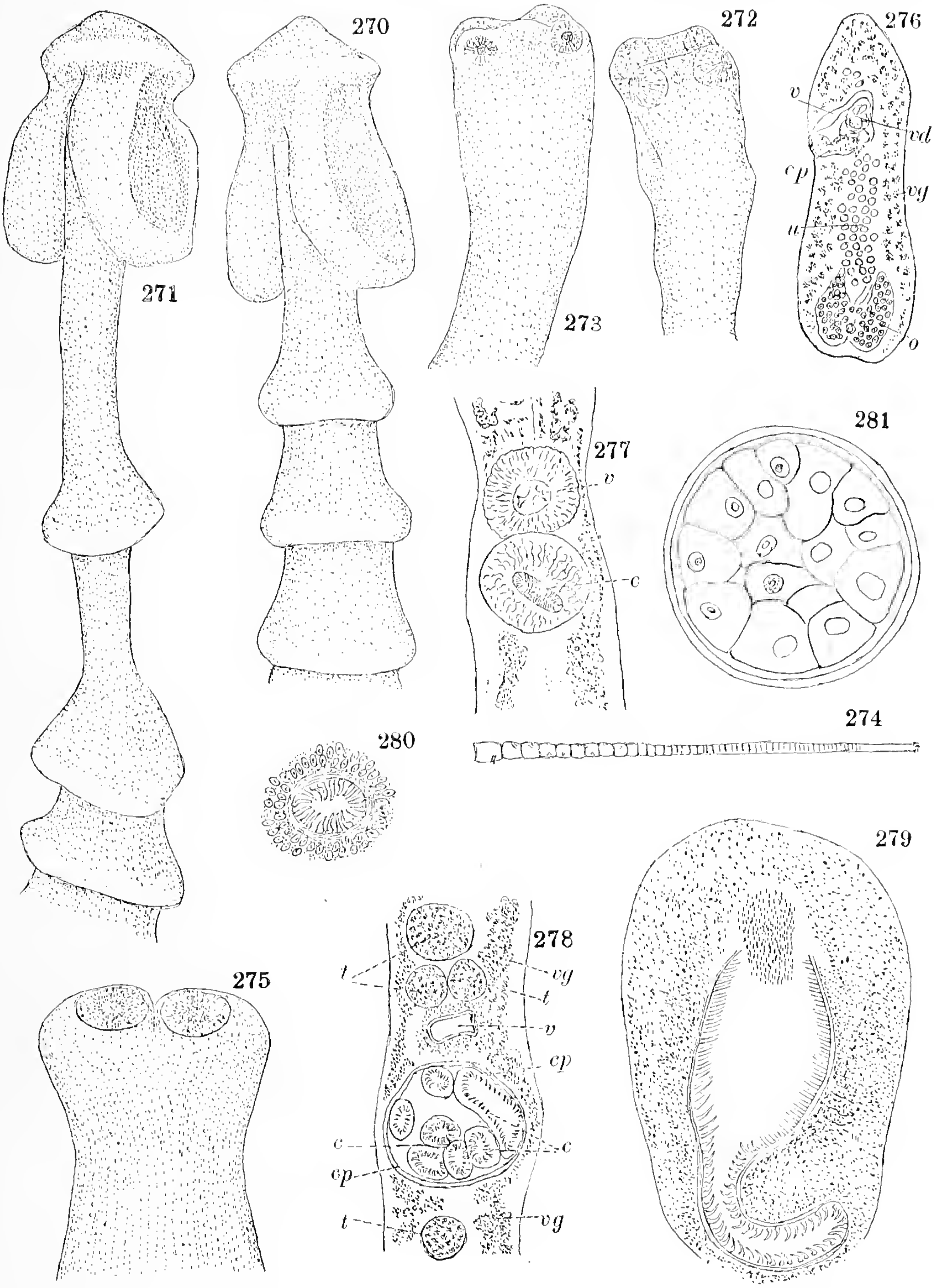
257–260. *Tetrarhynchus elongatus* Wagener, from liver of *Mola mola*. Proboscis. × 160.

259, near base; 260, base.

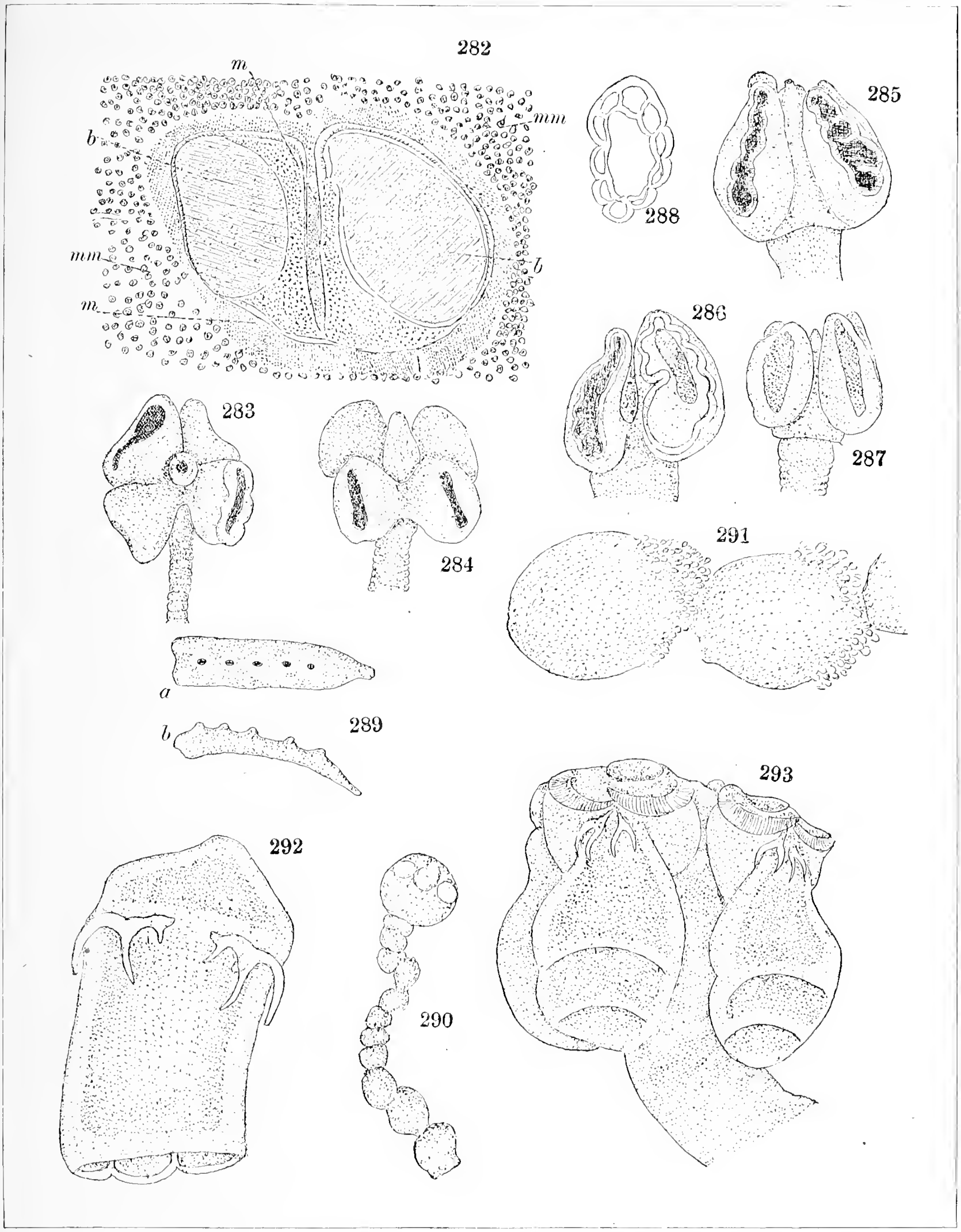
261. *Tetrarhynchus bisulcatus* Linton. Section of stomach wall of *Cynoscion regalis*, parasites encysted in submucosa. × 30.



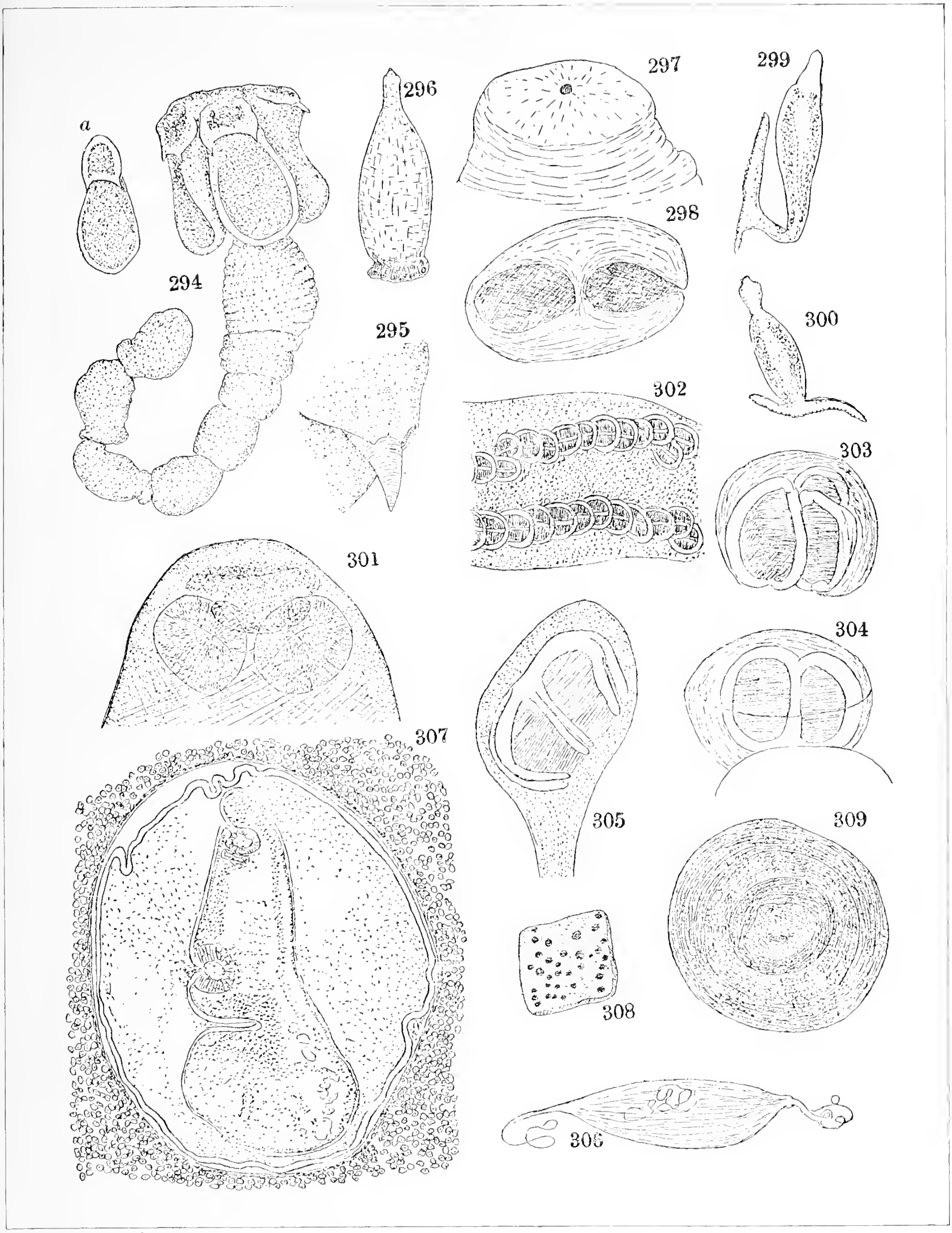
262. *Tetrarhynchus bisulcatus*, continued. Section of parasite, cut longitudinally, in submucous coat of stomach. × 50.
263. Transverse section through muscular bulb of proboscis. × 400. *n*, Nerve cells; *r*, retractor of proboscis.
264. *a*, Hooks in retracted proboscis of encysted parasite, × 800; *b*, *c*, groups of nerve cells lying beside contractile bulb, × 400; *d*, same, × 750.
265. Transverse section of dorsal muscles of *Rhombus triacanthus* with cysts containing *Rhynchobothrium* sp. × 30. (See 255-256*a*.)
266. *Dibothrium crassiceps* Rudolphi, from intestine of *Merluccius bilinearis*. Marginal view of head. × 40.
267. Lateral view of head. × 40.
268. Posterior end of strobile. × 40.
269. *Dibothrium angustatum* Rudolphi, from intestine of *Merluccius bilinearis*. *a*, Head, × 50; *b*, median segments, × 50; *c*, posterior segments, × 30.



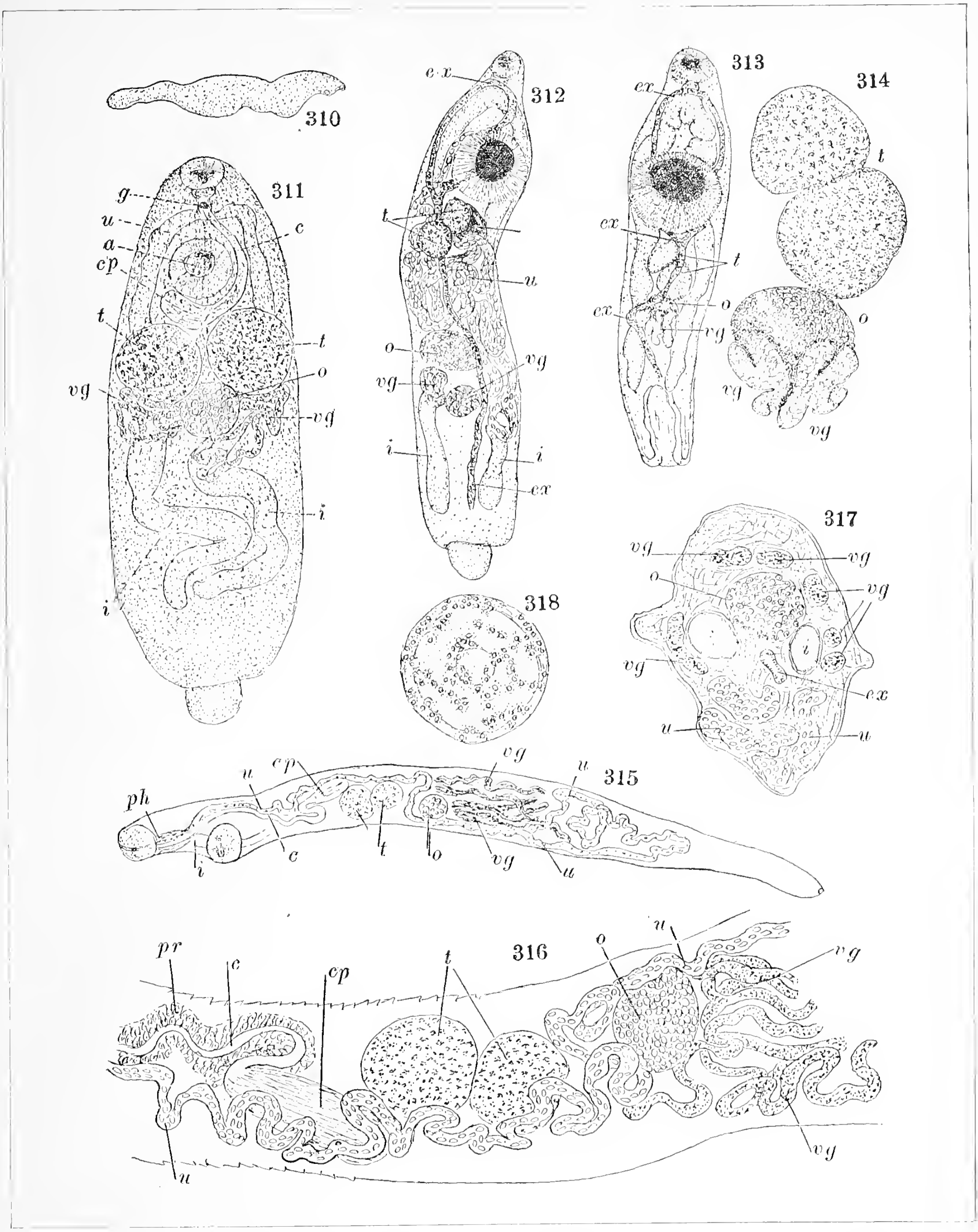
270. *Dibothrium microcephalum* Rudolphi, from intestine of *Mola mola*. Head with anterior segments, normal; life. × 65.
271. Abnormal lengthening of anterior segments; life. × 65.
272. *Tænia* sp. from intestine of *Anguilla chrysypa*. Head. × 40.
273. Head of another specimen. × 50.
274. *Tænia* sp. from intestine of *Sphyrna zygæna*. × 2.
275. Head of same. × 65.
276. Posterior segment. *cp*, Cirrus pouch; *o*, ovary; *u*, uterus; *v*, vagina; *vg*, vitelline glands. × 8.
277. Sagittal section of segment. × 100. *c*, Cirrus; *v*, vagina.
278. Sagittal section through cirrus pouch. *c*, Cirrus; *cp*, cirrus pouch; *t*, testes; *v*, vagina; *vg*, vitelline glands. × 100.
279. Cirrus, from transverse section of segment. × 300.
280. Transverse section of cirrus, showing cells of prostate gland and spines on retracted cirrus. × 400.
281. Segmenting ovum, in uterus. × 300.



282. *Tænia* sp. continued. Section of mucous membrane of intestine with head of parasite. ×300. *m*, Lining of pit and plug between bothria, structureless; *b*, bothria covered with fine spines; *mm*, mucous membrane.
283. *Echeneibothrium* sp. (near *E. affine* Olsson) from intestine of *Rhinoptera bonasus;* front view of head. ×65.
284. Lateral view of head of another specimen. ×65.
285–287. *Echeneibothrium* sp. from *Myliobatis freminvillei;* lateral view of heads of different individuals. ×65.
288. Plan of loculi on bothrium. ×65.
289. *Calliobothrium verticillatum* Rudolphi, from *Mustelus canis;* ripe segment with five apertures for discharge of ova. *a*, Flat surface of segment; *b*, marginal view.
290. *Paratænia medusia* Linton, from *Dasyatis centrura*, strobile; life. ×160.
291. Posterior segments; life. ×300.
292. *Phoreiobothrium triloculatum* sp. nov. from *Carcharinus obscurus;* single bothrium, showing characteristic trilocular border. ×100.
293. *Acanthobothrium coronatum* Rudolphi, from *Raja lævis.* Lateral view of scolex. ×65.

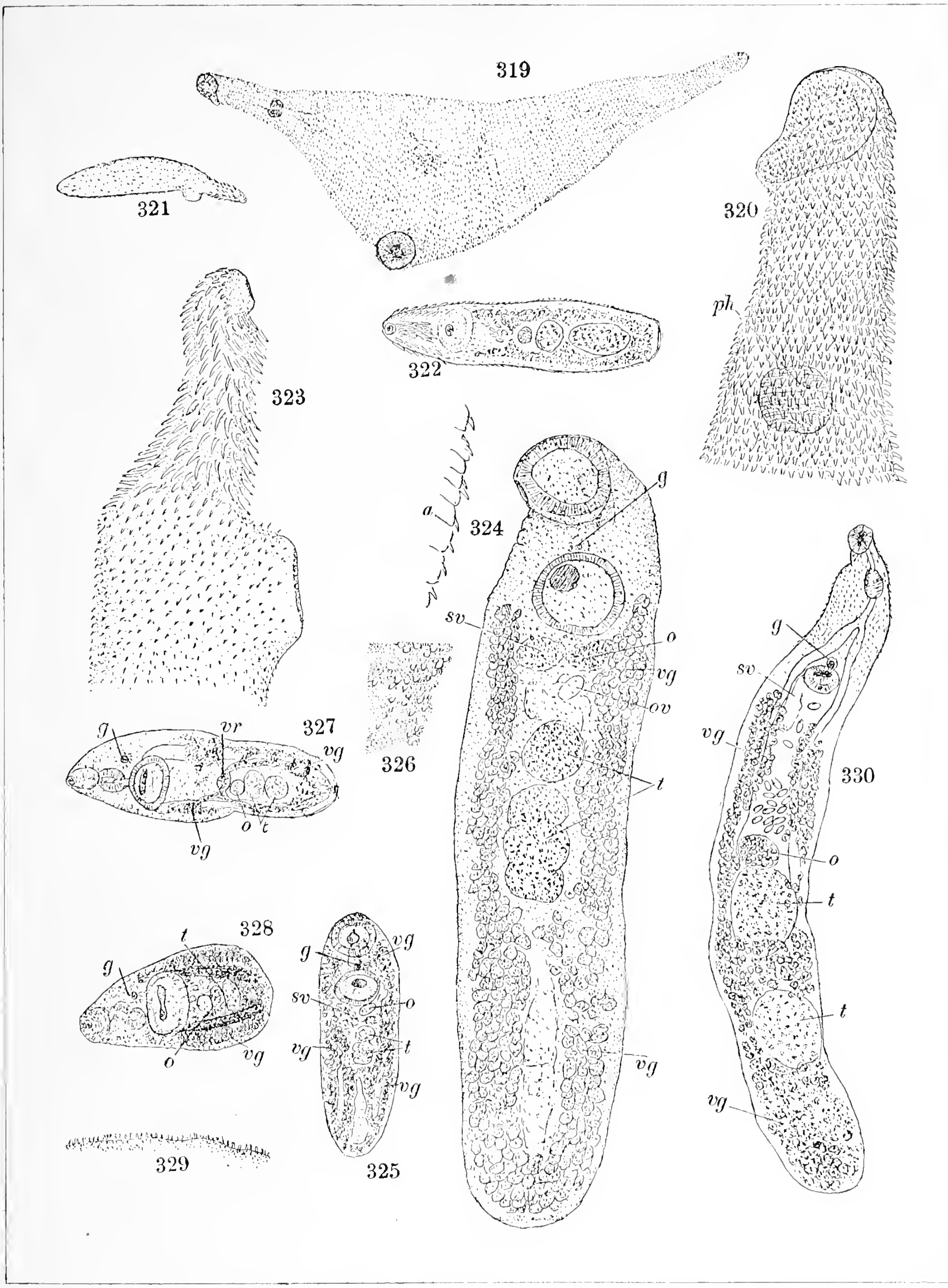


294. *Thysanocephalum ridiculum* sp. nov. from *Isurus dekayi*. Strobile. × 46. *a*, Bothrium from another specimen.
295. Hook and adjacent part of bothrium. × 300.
296. *Hexacotyle thynni* De la Roche (?), from mouth of *Sarda sarda*. Ventral view. × 6.
297. Mouth. × 300.
298. Single sucker. × 100.
299, 300. *Microcotyle* sp. from gill filaments of *Pomatomus saltatrix*. Two individuals, alcoholic. × 12.
301. Anterior end, ventral view. × 220.
302. Portion of posterior part of body, ventral view, showing sucking discs. × 100.
303–305. Different views of suckers. × 400.
306. Ovum. × 240.
307. *Diplostomum* sp. in globular cysts in liver of *Fundulus heteroclitus*; section of cyst and longitudinal section of parasite. × 100.
308. Cysts in liver of *Roccus lineatus*. × 1.
309. Calculus from cyst, showing concentric structure. × 300.



310. *Distomum tornatum* Rudolphi, from *Menidia notata;* lateral view; from life. × 3.
311. *Distomum* sp. from *Menticirrus saxatilis;* ventral view; life. *a*, Ventral sucker; *c*, cirrus; *cp*, cirrus pouch; *g*, genital aperture; *i*, intestine; *o*, ovary; *t*, testes; *u*, uterus; *vg*, vitelline glands. × 40.
312. *Distomum appendiculatum* Rudolphi, from *Decapterus macarellus;* adult, ventral view. *ex*, Excretory vessel; *u*, uterus. Other letters as in fig. 311. × 46.
313. Young, ventral view. Letters as in figs. 311, 312. × 46.
314. Testes, ovary, and vitellaria of young. Letters as in fig. 311. × 220.

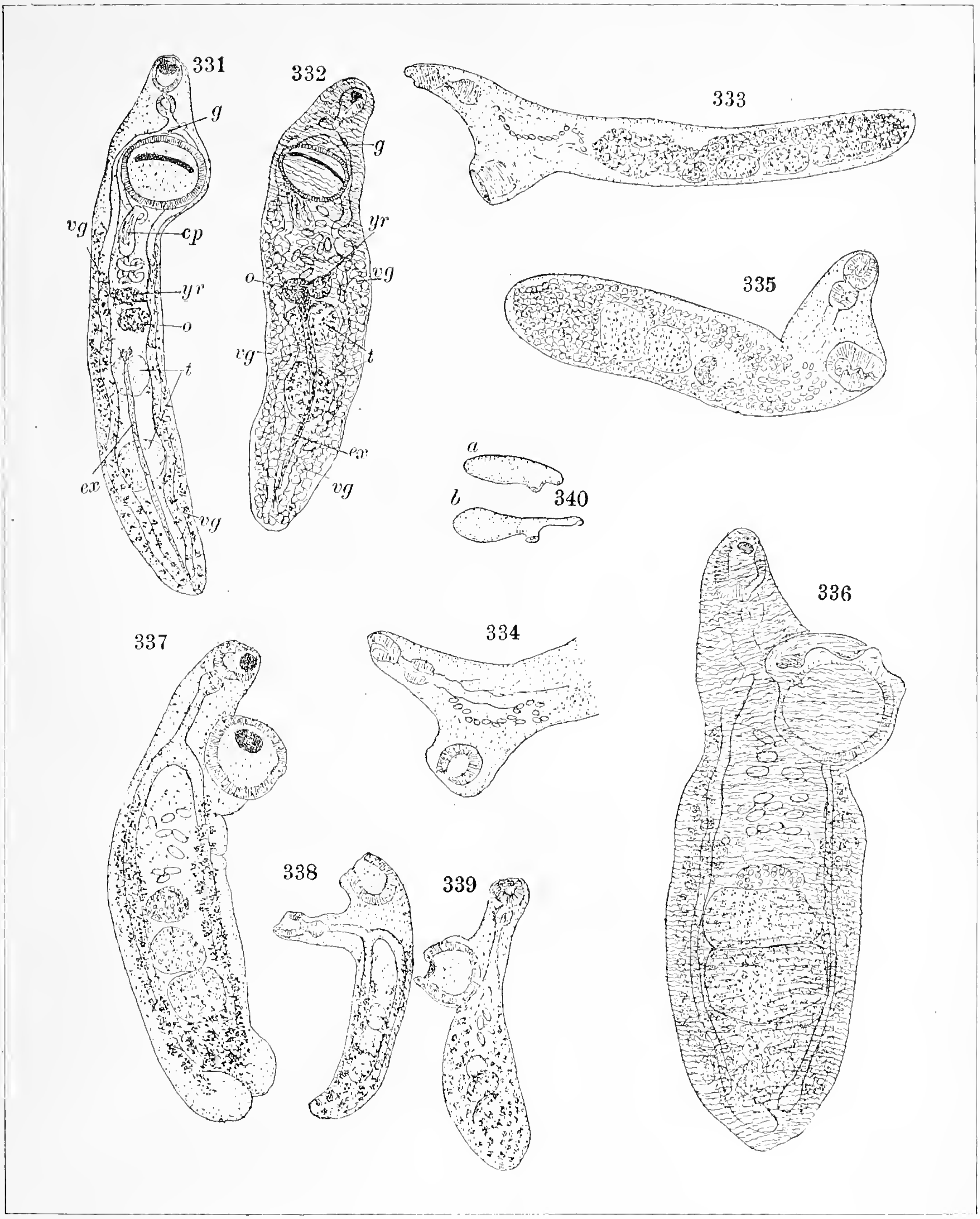
Note.—The vitellaria, which are deeply lobed in the young, appear to lose this character in the adult.
315. *Distomum gulosum* sp. nov. from *Rhombus triacanthus;* lateral view. × 18. *ph*, The long, cylindrical pharynx. Other letters as in figs. 311, 312.
316. Middle of body of same. × 65. *pr*, Prostate gland. Other letters as in figs. 311, 312.
317. Transverse section of body through ovary. × 65. Letters as in figs. 311, 312.
318. Eye of *Tautoga onitis*, distomes encysted in cornea. × 2.



319. *Distomum* sp. from *Stolephorus brownii;* lateral view of mounted specimen. × 100.
320. Head and neck of same. × 400. *ph*, Pharynx.
321. *Distomum hispidum*, from *Phycis tenuis;* side view; ale. × 7.
322. Ventral view. × 14.
323. Anterior end, side view. × 65.

Undetermined distomes from Opsanus tau.

324. Ventral view of larger distome. [See A, p. 469.] × 46. *g*, Genital aperture; *o*, ovary; *sv*, seminal vesicle; *t*, testes; *vg*, vitelline glands; *ov*, ovum; *a*, margin, showing spines. × 400.
325. Ventral view of smaller distome. Letters as in fig. 324. × 46.
326. Spines on ventral side of neck of same. × 400.
327. Ventral view of another. *vr*, Vitelline reservoir. Other letters as in fig. 324. [See B, (*a*), p. 469.] × 46.
328. Ventral view of another. Letters as in fig. 324. [See B, (*b*), p. 469.] × 46.
329. Posterior margin of latter. × 400.
330. *Distomum* sp. from *Enchelyopus cimbrius;* ventral view. Letters as in fig. 324. × 46.



331. *Distomum simplex* Rudolphi, from *Microgadus tomcod;* young specimen compressed and killed by application of heat. Ovary very indistinctly lobed. *cp*, Cirrus pouch; *ex*, excretory vessel; *g*, genital aperture; *o*, ovary; *t*, testes; *vg*, vitelline glands; *yr*, yolk reservoir. × 65.

332. An adult with ova. Letters as in fig. 331. × 46.

333. *Distomum vitellosum* Linton, from *Stenotomus chrysops;* specimen made turgid by placing in fresh water. × 46.

334. Another from same host, but collected on different date, anterior end. × 46.

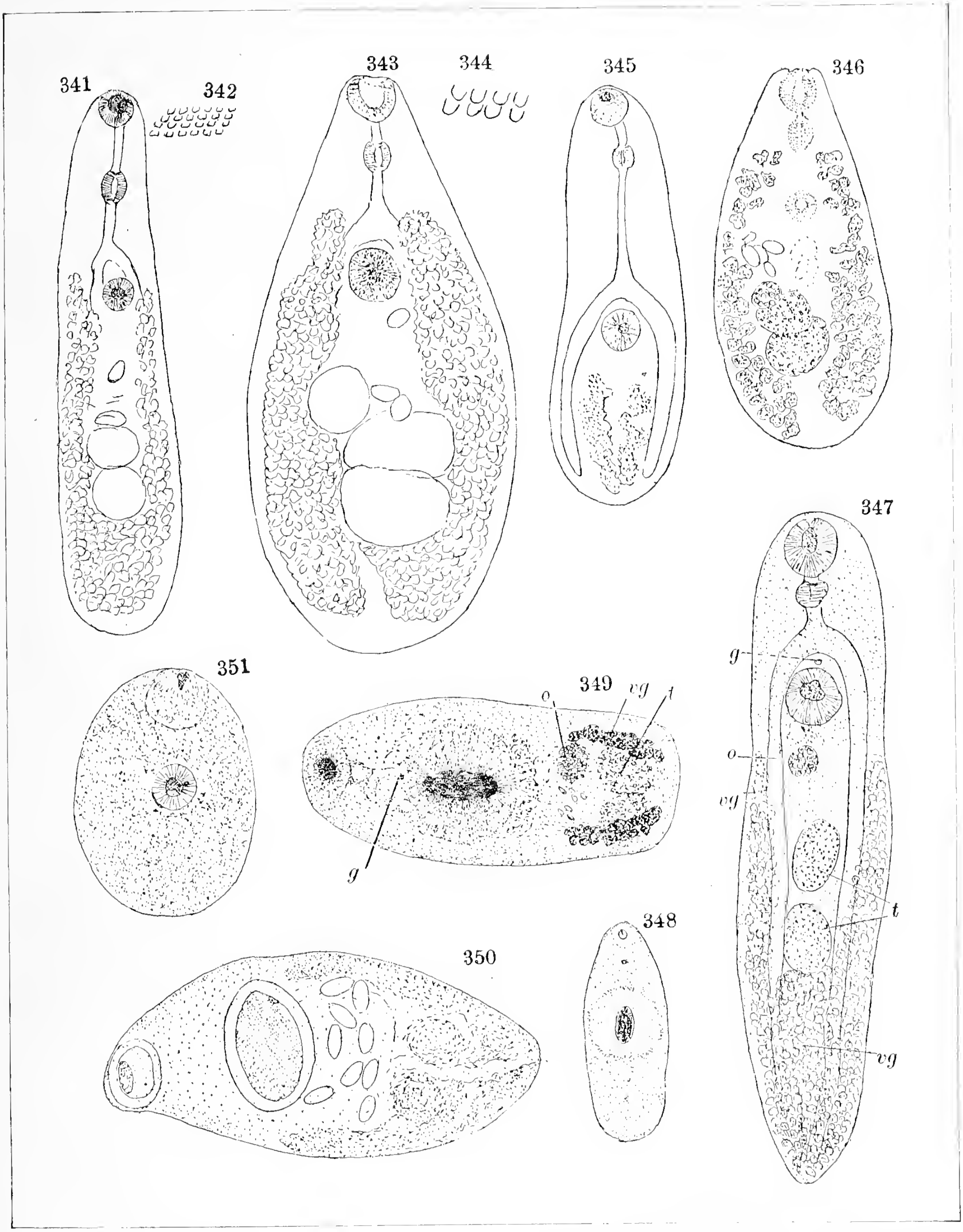
335. A specimen from *Merluccius bilinearis.* × 50.

336. A small specimen, finely corrugated with transverse wrinkles, from *Paralichthys dentatus.* × 100.

337. A specimen from *Pomatomus saltatrix;* sketched from living worm slightly compressed. × 65. *f*, Posterior flaps, which were used by the worm as independent organs, which appeared to have a kind of clasping function.

338, 339. Two other smaller individuals from same lot, made turgid with fresh water. × 65.

340. Specimen from *Pseudopleuronectes americanus.*
a and *b*, Sketches of same worm in different stages of contraction. × 20.

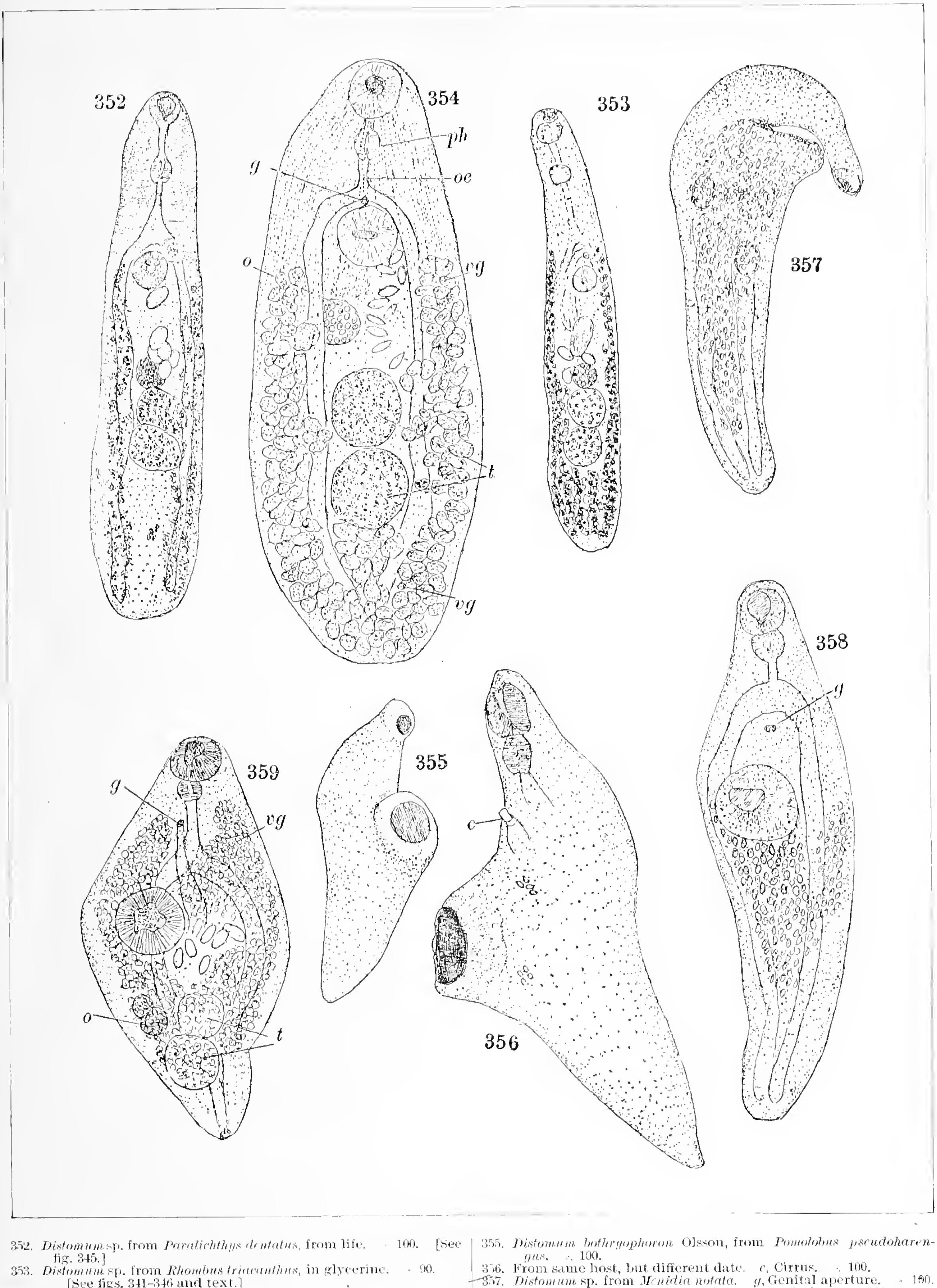


341. *Distomum* sp. from *Pomatomus saltatrix*, slender variety. × 100.
342. Spines on neck of same. × 400.
343. Oval variety. × 100.
344. Spines on neck of same. × 400.
345. Probably same species, young, from *Paralichthys dentatus*. × 100.
346. Species near *Distomum pyriforme* Linton, from *Stenotomus chrysops*. × 100.

[See figs. 352–354 and descriptions in text.]

347. *Distomum globiporum* Rudolphi (?), from *Pseudopleuronectes americanus*. × 30. *g*, Genital aperture; *o*, ovary; *t*, testes; *vg*, vitelline glands.
348. *Distomum* sp. from *Raja lævis*. × 8.
349. Same, in glycerine. Letters as in fig. 347. × 14.
350. *Distomum* sp. from *Gasterosteus bispinosus*. × 100.
351. Young distome from *Achirus fasciatus*. × 220.

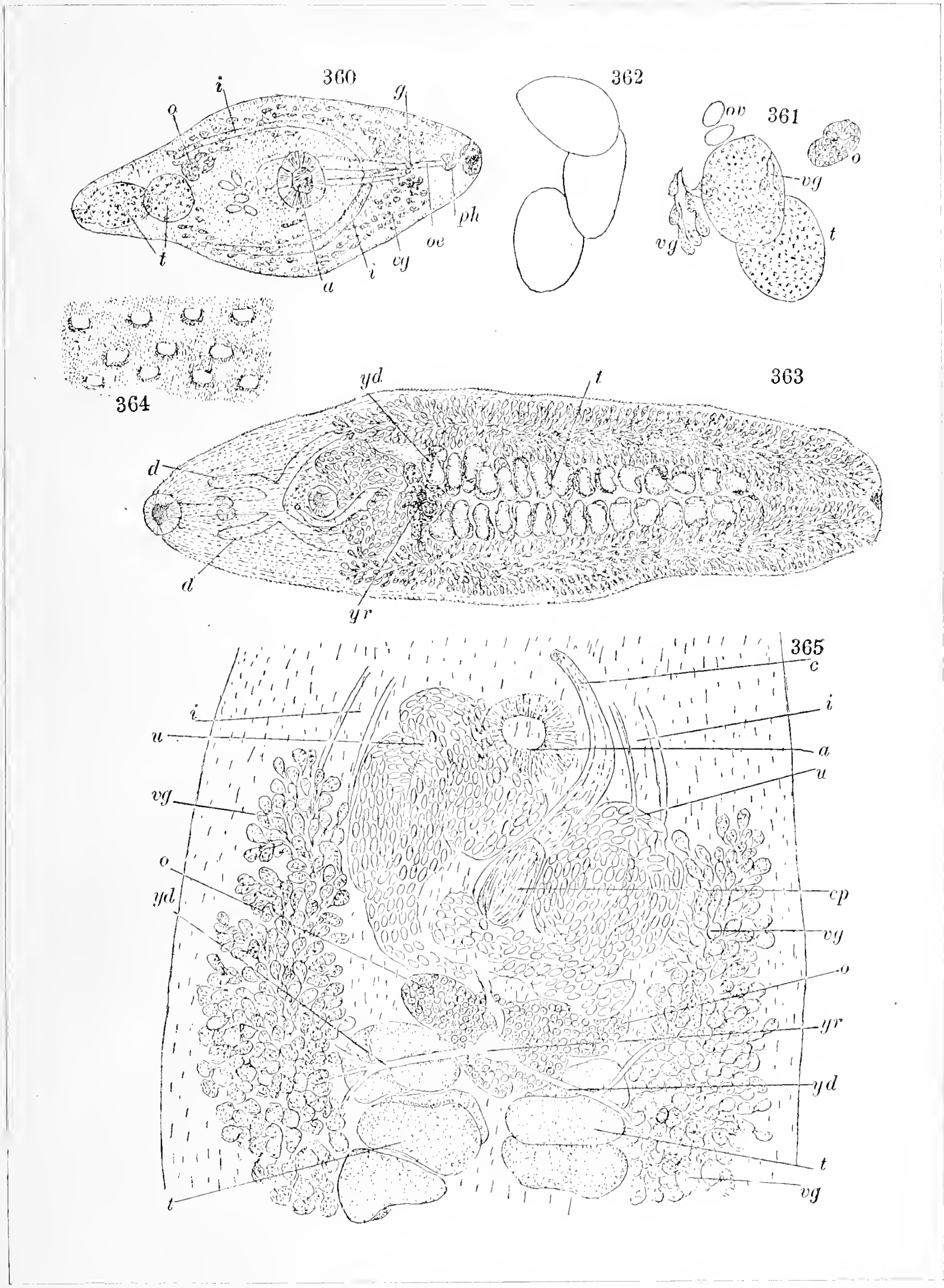
PLATE XXXII.



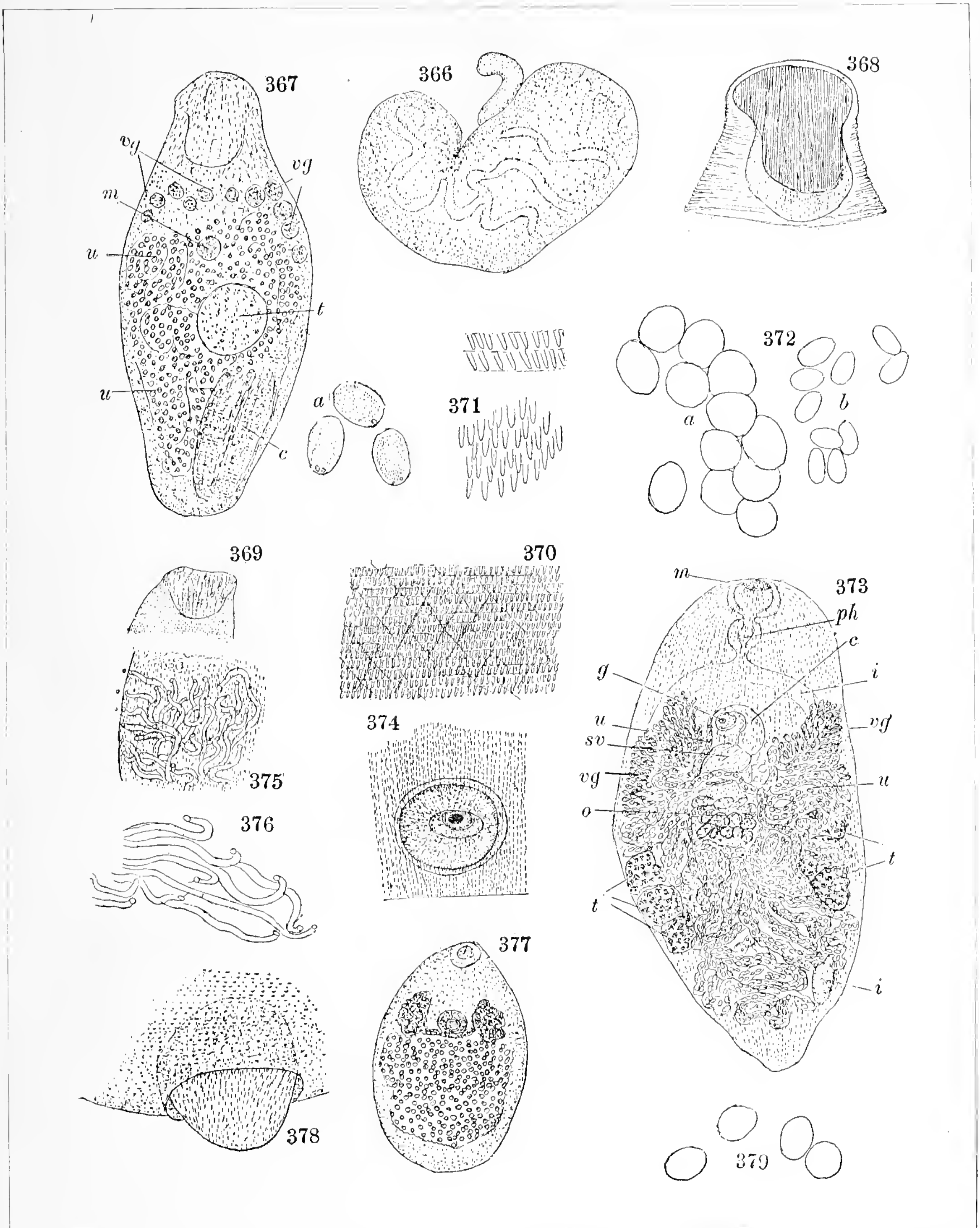
352. *Distomum* sp. from *Paralichthys dentatus*, from life. × 100. [See fig. 345.]
353. *Distomum* sp. from *Rhombus triacanthus*, in glycerine. × 90. [See figs. 341–346 and text.]
354. *Distomum* sp. from *Fundulus heteroclitus*. Minute spines on body. × 50. *g*, Genital aperture; *o*, ovary; *oe*, œsophagus; *ph*, pharynx; *t*, testes; *vg*, vitelline glands.

355. *Distomum bothryophoron* Olsson, from *Pomolobus pseudoharengus*. × 100.
356. From same host, but different date. *c*, Cirrus. × 100.
357. *Distomum* sp. from *Menidia notata*. *g*, Genital aperture. × 100.
358. Another specimen from same host, ventral view. × 100.
359. *Distomum* sp. from *Limanda ferruginea*, ventral view. Letters as in fig. 351. × 46.

= [illegible] Chandler Proc USNM 83:128



360. *Distomum* sp. from *Limanda ferruginea*, continued. Restored from sections, partly diagrammatic. *a*, Ventral sucker; *g*, genital aperture; *i*, intestine; *o*, ovary; *oe*, œsophagus; *ph*, pharynx; *t*, testes; *vg*, vitelline glands. × 46.
361. Testes, ovary, ova, and portion of vitellaria. Letters as in fig. 360. × 80.
362. Ova. × 300.
363. *Distomum polyorchis* Stossich, from *Cynoscion regalis;* ventral view; life. × 30. *d*, Diverticula of intestine; *t*, testes; *yd*, vitelline duct; *yr*, vitelline reservoir, lying on ventral side of ovary.
364. Spines on neck. × 400.
365. Details of post-acetabular region, ventral view. × 100. *c*, Cirrus; *u*, uterus. Other letters as in figs. 360, 363.



366. *Distomum* (*Köllikeria*) sp., from cyst in intestinal wall of *Scomberomorus maculatus*. Side view, life. × 100.
367. *Gasterostomum* sp., from *Tylosurus marinus*. × 100. *c*, Cirrus; *m*, mouth; *t*, testes; *u*, uterus; *vg*, vitelline glands; *a*, ova. × 400.
368. Anterior end of specimen collected on different date. × 100.
369. *Gasterostomum* sp., from *Scomberomorus maculatus*; anterior end of specimen in glycerine. × 65.
370. Spines on neck, highly magnified.
371. Same. × 1,200.
372. Ova, two sizes, in uterus of same worm; *a*, large; *b*, small; life. × 400.
373. *Monostomum vinal-edwardsii* sp. nov., from *Opsanus tau*; ventral view; life. *c*, Cirrus; *g*, genital acetabulum; *i*, intestine; *m*, mouth; *o*, ovary; *ph*, pharynx; *sv*, seminal vesicle; *t*, testes; *u*, uterus; *vg*, vitelline glands. × 45.
374. Genital acetabulum; life. × 220.
375. Excretory vessels in neck, dorsal view; highly magnified.
376. Same, more highly magnified.
377. *Monostomum* sp., from *Pomolobus pseudoharengus*; ventral view; life. × 100.
378. Genital acetabulum; life. × 400.
379. Ova; life. × 400.

= Rhipidocotyle transversale

INDEX.

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